

Cambridge IGCSE[™]

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

4 9 1 6 2 4 3 6 4

CO-ORDINATED SCIENCES

0654/33

Paper 3 Theory (Core)

October/November 2022

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do not use an erasable pen or correction fluid.
- Do not write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

1 (a) A student investigates the germination of pea seeds.

The student places pea seeds in test-tubes with different conditions and records whether the seeds germinate.

Table 1.1 shows the conditions for each test-tube.

Table 1.1

test-tube	water present?	oxygen present?
Α	yes	yes
В	yes	no
С	no	no
D	no	yes

	(i)	Predict in which test-tube the pea seeds will germinate.	
			[1]
	(ii)	State one other requirement for germination that is not tested in Table 1.1.	
			[1]
(b)	Afte	er the seeds germinate, the plant photosynthesises.	
	(i)	Complete the sentence to define photosynthesis.	
		Photosynthesis is the process by which plants manufacture	
		from raw materials using energy	
		from	[2]
	(ii)	State the two raw materials needed for photosynthesis.	
		1	
		2	 [2]
(c)	Dog	as contain protein.	[4]
(C)	rea	as contain protein.	
	Stat	te the name of the smaller molecules from which protein is made.	
			[1]

[Total: 7]

2 (a) Petroleum is a fossil fuel.

(b)

State the name of one other fossil fuel.	
	[1]
Petroleum is separated into useful fractions by fractional distillation.	
State why fractional distillation is a physical change and not a chemical change.	

......[1]

(c) The fractions obtained from petroleum have different uses.

On Fig. 2.1, draw **one** line from each fraction to its use. One line has been drawn for you.

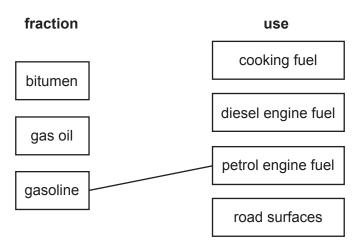


Fig. 2.1

[2]

(d) Ethane and ethene are both found in petroleum. Ethane, C₂H₆, is an alkane. Ethene, C₂H₄ is an alkane.

(i) Explain why ethene is described as being unsaturated.



(ii)	State the chemical test used to distinguish between an alkane and an alkene.	
	Describe the observation for an alkane and for an alkene.	
	test	
	observation for alkane	
	observation for alkene	
		 [3]
(iii)		[J]
(111)	State the total number of atoms in one molecule of ethene, C ₂ H ₄ .	[1]
(iv)	Complete Fig. 2.2 to show the structural formula of ethane, C ₂ H ₆ .	נין
(14)	Complete Fig. 2.2 to show the structural formula of ethane, O_2^{-1} 6.	
	Fig. 2.2	
		[2]
(v)	Ethene molecules react together when heated to make a polymer.	
	State the name of the polymer made from ethene.	
		[1]
	[Total: ´	12]

3 (a) Fig. 3.1 shows four forces acting on a submarine. The submarine is moving underwater at a constant speed.

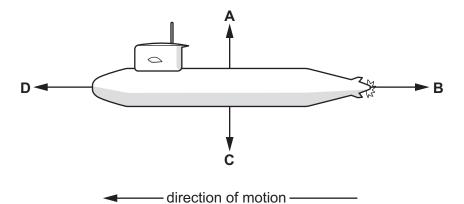


	Fig. 3.1	
	State which force A, B, C or D is the weight of the submarine.	
		[1]
(b)	The submarine travels 36 km in 2 hours.	
	Calculate the speed of the submarine in m/s.	

speed =	 m/s	[3
opood	 1117 0	10

- (c) The submarine is powered by a small nuclear reactor.
 Ionising radiation is released in the reactor.
 The reactor must be shielded to protect the crew from this radiation.
 - (i) State how exposure to ionising radiation can affect the human body.

......[1]

(ii) Suggest a material which can be used to shield a nuclear reactor and stop α -radiation and β -radiation escaping.

.....[1]

(d) Plutonium-239 (Pu-239) is the nuclear fuel used by the submarine. Pu-239 has a half life of 24 000 years. A small sample of Pu-239 has a mass of 1.0 g.

Calculate the mass of Pu-239 remaining after 96 000 years.

(e) When it is under the water, the submarine uses a periscope to view a ship on the surface of the sea.

Fig. 3.2 shows a simple periscope.

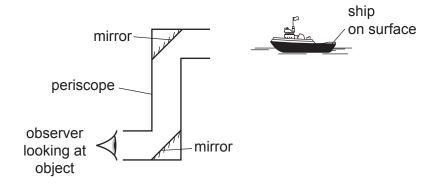


Fig. 3.2

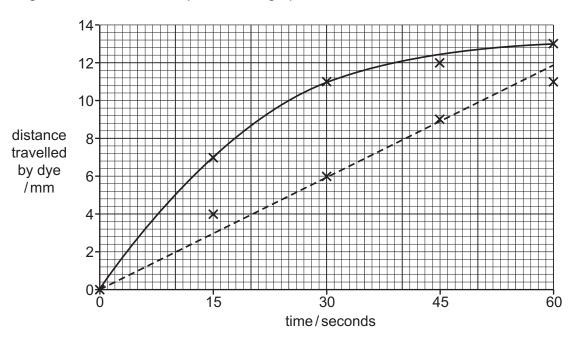
On Fig. 3.2, draw a ray of light from the ship to the observer's eye to show what happens to the light ray as it passes through the periscope. [2]

[Total: 10]

4 (a) Scientists investigate diffusion by measuring the distance travelled by two different dyes **X** and **Y**.

They place the dyes on agar plates and measure the distance travelled every 15 seconds.

Fig. 4.1 shows the results plotted on a graph.



Key

x potassium manganate(VII) — **x**

Y methyl orange

Fig. 4.1

(i) Describe the general trend shown by both dyes in Fig. 4.1.

• • • • • •	 	 	 	 	 	 	
							[1]

(ii) The dyes move through the agar by diffusion.

The scientists calculate the average rate of diffusion for dye **X** after 30 seconds as:

$$\frac{\text{distance travelled}}{\text{time taken}} = \frac{11}{30} = 0.37 \,\text{mm/s}$$

Calculate the average rate of diffusion for dye **Y** after 30 seconds.

(b)	Des	scribe	he direc	tion of moti	on of parti	icles during	diffusio	on.			
											[2]
(c)	Sub	ostance	es move	into and ou	it of cells b	by diffusion.					
	(i)	State	the part	of the cell t	that contro	ols the move	ement o	of substan	ces in a	nd out of	the cell.
											[1]
	(ii)	Circle	two su	bstances th	at diffuse	into cells fo	r respir	ation.			
			car	bon dioxid	е	fatty acids	i	glucos	е		
				oxyger	า	starch	wa	ater			
											[2]
(d)	Tab	le 4.1	shows s	ome compo	nents of p	olant cells a	nd their	r function.			
	Cor	mplete	Table 4.	1.							

Table 4.1

component of plant cell	function
	contains cell sap to support the plant cell
cytoplasm	
	where photosynthesis occurs

[3]

[Total: 11]

5	(a)	The	list below	shows the	ecules.						
				CH ₄	Cl_2	СО	N_2	NH_3	O ₂		
		Iden	itify which	of the mo	lecules fror	n the list is	s:				
		(i)	an ammo	onia molec	ule						
											[1]
		(ii)	a molecu	lle used in	the treatme	ent of wate	er				
											[1]
		(iii)	a molecu	le formed	during the	incomple	te combu	stion of ca	rbon-containi	ng substan	ces
											[1]
		(iv)	the mole	cule of the	gas that is	78% of cl	ean dry a	ir			
											[1]
		(v)	a molecu	le that con	itains four o	covalent b	onds.				
											[1]
	(b)	Lime	e (calcium	oxide) is ı	made from	limestone	(calcium	carbonate) by thermal	decomposit	tion.
		(i)	State the	name of t	he other pr	oduct of th	nis reactio	n.			
											. [1]
		(ii)	Calcium	carbonate	is not a fer	tiliser but i	s often a	dded to soi	l.		
			Explain v	vhy calciur	n carbonat	e is often a	added to	soil.			
											. [1]
		(iii)	List the t	hree esser	ntial eleme	nts neede	d in a ferti	liser.			
			1								
			2								
			3								[2]
										[Tota	al: 9]

6 Bats use the reflection of sound waves to determine the position of objects.

Fig. 6.1 shows a bat, and a moth flying in front of the bat.

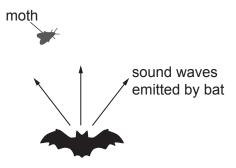


Fig. 6.1

(a)	State the name given to a reflected sound wave.	
----	---	---	--

.....[1]

- **(b)** Some bats are able to detect ultraviolet radiation. Ultraviolet radiation is part of the electromagnetic spectrum.
 - (i) On the incomplete electromagnetic spectrum shown in Fig. 6.2, place ultraviolet in the correct position.

	X-rays		infrared	radio waves	

Fig. 6.2

[1]

- (ii) State which part of the electromagnetic spectrum has the lowest frequency.
 -[1]
- (c) A bat produces a sound wave with a frequency of 200 kHz and a wavelength of 0.0016 m.
 - (i) Draw straight lines to link each wave term to its definition.

term definition

distance between the peaks on consecutive waves

frequency maximum displacement of points on a wave

number of waves passing a fixed point per second

[2]

(ii)	Explain why a human cannot hear the sound emitted by the bat.	
		 [1]
(iii)	The bat changes the frequency of the sound it produces from 200 kHz to 250 kHz.	
	State what happens to the pitch of the sound.	
		[1]
	[Total:	7]

7 (a) Students in a school measure their hand-span.

Fig. 7.1 is a photograph showing the measurement that each student takes.

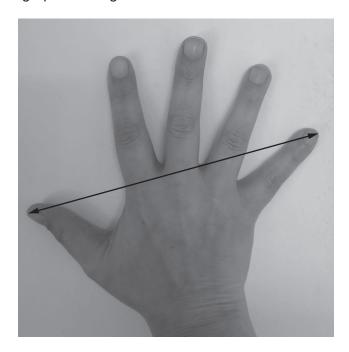


Fig. 7.1

Fig. 7.2 is a histogram showing the results.

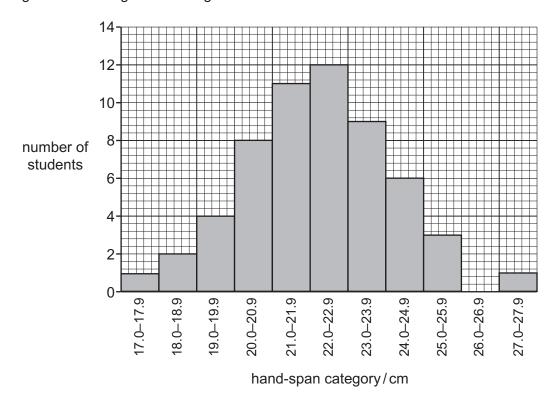


Fig. 7.2

(i) Determine which hand-span category has the most students.

(ii)	Determine the number of students with a hand-span of 19.0–19.9 cm.					
(iii) Histograms are used to display data that show continuous variation. What ot from Fig. 7.2 shows that hand-span is an example of continuous variation?						
(iv)			ole of continuous variation			
					[1]	
	•	·	e, genetic diagram.			
(i)	Complete Fig. 7.	s to snow now sex	is inherited in humans.		٦	
		male sex chromosomes				
			x	Y		
	emale sex					
GI	- Composition					
		Fig	g. 7.3		[2	
(ii)	Use Fig. 7.3 to de	etermine the ratio	of male offspring to fema	le offspring.		
		male :	fen	nale	[1]	

gene nucleus

(c) Several structures are involved in inheritance.

Place structur	es from the list in order of size from smallest to largest.
smallest	
largest	

chromosomes DNA

[2]

[Total: 9]

8 (a) Potassium is an element in the Periodic Table.

Use numbers from the list to complete the sentences about potassium. Each number may be used once, more than once or not at all.

1 2 3 8 19 20 39

Potassium is an element in group of the Periodic Table.

A potassium atom has a total of electrons.

A potassium ion has a positive charge of

[3]

(b) Sodium and chlorine react to form sodium chloride.

Fig. 8.1 shows the electronic structure of a sodium atom and a chlorine atom.

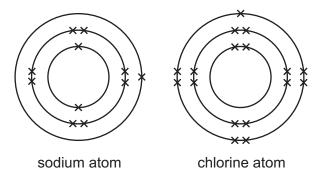


Fig. 8.1

Complete the diagrams in Fig. 8.2 to show the electronic structure of the ions in sodium chloride.

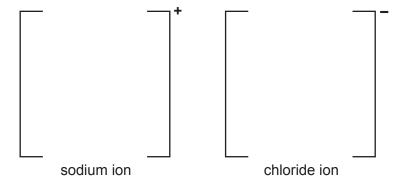


Fig. 8.2

[2]

(c) Fig. 8.3 shows the electrolysis of concentrated aqueous sodium chloride.

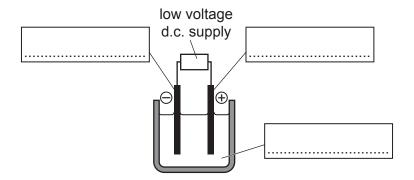


Fig. 8.3

- (i) Complete Fig. 8.3 by labelling the:
 - anode
 - cathode
 - electrolyte.

[Total: 10]

[2]

[2]

9 Fig. 9.1 shows an aircraft at rest on a runway.

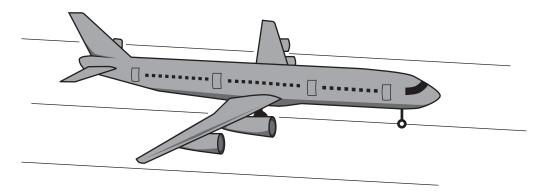


Fig. 9.1

(a)	The mass	of the	aircraft i	is ·	400 000 kg.
-----	----------	--------	------------	------	-------------

Calculate the weight of the aircraft. The gravitational field strength, *g*, is 10 N/kg.

weight =	N	[2]
WOIGHT	 	14

- (b) The aircraft starts from rest and accelerates along the straight runway. The aircraft engines produce a constant horizontal thrust force of 1 200 000 N. A constant frictional force of 500 000 N acts on the aircraft.
 - (i) Calculate the resultant horizontal force acting on the aircraft.

		force =	N [1]
ii)	Explain why the aircraft accelerates.		

(c) Fig. 9.2 shows a TV monitor in the cabin of the aircraft and the energy transferred each second by the monitor.

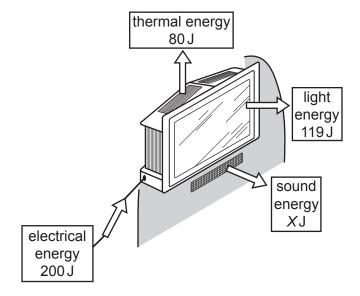


Fig. 9.2

(i)	The number of joules of sound energy transferred per second is shown as XJ .
	Calculate the value of X.

X = .		J	[1	1	
-------	--	---	----	---	--

(ii) The monitor has a resistance of $1900\,\Omega$. The current passing through the monitor when in use is 0.060A.

Calculate the potential difference across the monitor. State the unit of your answer.

potential difference = unit [3]

The current of 0.060A is the same as 60 mA.

(iii)

The fuse in the electrical supply to the monitor has to be replaced. Several fuse ratings are available.					
10 mA	50 mA	100 mA	250 mA		
State which fuse is t	he correct choic	ce.			
Explain your answer	-				
fuse =	mA				
explanation					

[Total: 10]

[2]

10 (a) Fig. 10.1 is a diagram of the alimentary canal and associated organs in a human.

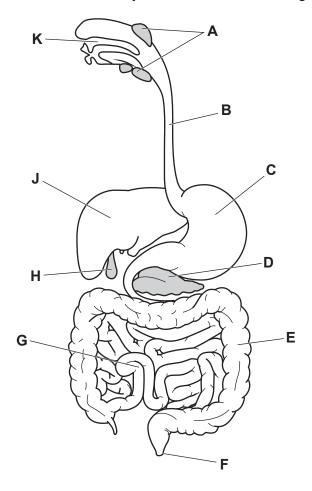


Fig. 10.1

(i)	Identify the letter in Fig. 10.1 that represents the part where:					
	ingestion occurs					
	egestion occurs					
	mechanical digestion occurs					
	saliva is produced.		[4]			
(ii)	State the name of the parts labelled	D and H in Fig. 10.1.				
	D					
	H					
			ا کا			

(b) Table 10.1 shows some features of absorption and assimilation.

Place ticks (✓) in the boxes to show the features of each process.

Table 10.1

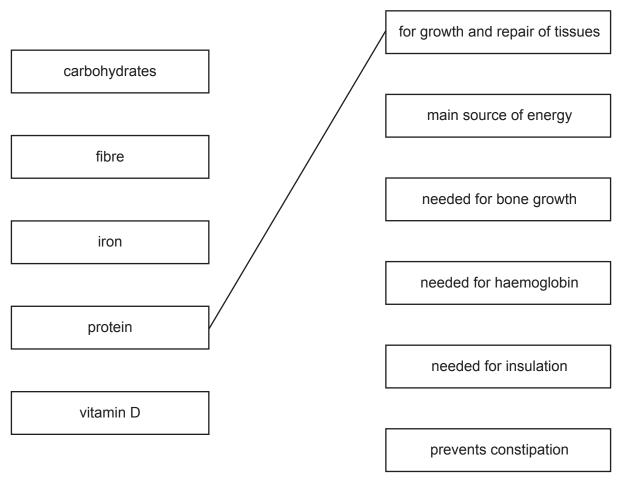
		feature	
process	movement of digested food molecules	movement into blood	movement into cells
absorption			
assimilation			

[3]

(c) Draw a line to link each component to its dietary importance.

One has been done for you.

component dietary importance



[4]

[Total: 13]

11 Fig. 11.1 shows the apparatus and reagents used to make a salt.

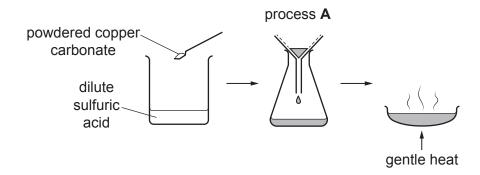


Fig. 11.1

(a)	(i)	State the name of process A shown in Fig. 11.1.
		[1]
	(ii)	State the name of the salt made in this experiment.
		[1]
	(iii)	Carbon dioxide gas is also made.
		Explain why the bonds between the carbon atoms and the oxygen atoms in carbon dioxide are covalent.
		[1]
((iv)	The temperature of the reacting mixture increases during the reaction.
		State the name given to all chemical reactions that release heat.
		[1]
	(v)	The experiment is repeated using large pieces of copper carbonate instead of powdered copper carbonate.
		State what happens to the rate of reaction.
		[1]

(b)	-	oper carbonate is green. Copper is a transition metal. e of the properties of transition metals is that they form coloured compounds.	
	Stat	te two other properties of transition metals which are not properties of all metals.	
	1		
	2		[2]
(c)	Bras	ss is a mixture containing copper and zinc.	
	(i)	State the name given to a mixture of metals.	
			. [1]
	(ii)	State one advantage of brass compared to copper.	
			. [1]
		[Tota	al: 9]

12 An astronomer observes a large meteorite, a rock from outer space. The astronomer uses a telescope which contains mirrors.

Fig. 12.1 shows the image of the meteorite seen in the mirror by the astronomer.



Fig. 12.1

(a) Select **two** words or phrases from the list to describe the characteristics of an image formed by a single plane mirror.

	diminished	enlarged	inverted	same size	upright	
1						
2						
				•••••		[2]

(b) The meteorite enters the Earth's atmosphere.

Fig. 12.2 is a speed-time graph for the meteorite as it approaches Earth.

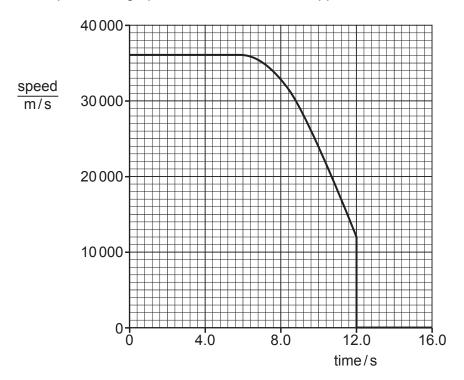


Fig. 12.2

(i) On Fig. 12.2, label with an S a point when the meteorite is slowing down. [1](ii) State the form of energy lost by the meteorite as it slows down.

(iii) Use Fig. 12.2 to determine the maximum speed of the meteorite.

speed m/s [1]

(c) The mass of the meteorite is $22\,500\,\text{kg}$. The density of the meteorite is $7500\,\text{kg/m}^3$.

	(i)	Calculate the volume of the meteorite.
		volume = m ³ [2]
	(ii)	A scientist suggests that the meteorite contains metallic iron.
		Suggest a simple way for the scientist to test for iron in an object found on Earth.
		[1]
(d)		meteorite's temperature is 1500 °C when it falls into the sea. meteorite loses thermal energy to the water.
	(i)	State the main method of thermal energy transfer from the meteorite into the water.
		[1]
	(ii)	Some of the seawater evaporates.
		Describe the process of evaporation in terms of the movement and energy of water molecules.
		[2]

(iii) The meteorite is a solid and the seawater is a liquid.

Draw more circles in the boxes in Fig. 12.3 to show the arrangement and separation of particles in a solid and in a liquid.

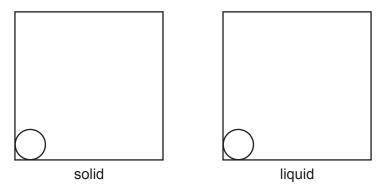


Fig. 12.3

[2]

[Total: 13]

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The Periodic Table of Elements

	IIIA IIA IA	2 He)	helium 4	5	οЦ	fluorine	9 Huodine 19 17	9 F Huorine 19 17 Cl	9 F Huorine 19 17 17 C I chlorine 35.5	9 F Huorine 19 17 17 C I C I Chlorine 35.5	9	9 Huome 19 17 17 C1 chome 35.5 Br bromine 80	9 Huome 19 17 17 C1 chome 35.5 Br bromine 80	9 Ruorine 19 17 17 C1 chlorine 35.5 Br bromine 80 81	9	9	9 Huorine 19 17 17 Cl Cl Cl Chlorine 35.5 Br Brownine 80 80 53 I I bodine 127 At	Neilum Neilum 8 9 10 0 F Ne 10 17 18 12 17 18 13 25.5 40 34 35.5 40 35 84 85 127 131 128 127 131 138 86 148 85 86 150 150 150	9 Huorine 19 17 C1 C1 Cibionie 35.5 Br brownine 80 80 53 I lodine 127 At astatine	-
	>																		N 144 144 145 145 146 146 146 146 145		
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89 П	erbium 167	100	Fm	fermium	I
67 Ho	holmium 165	66	Es	einsteinium	_
% O	dysprosium 163	86	ర	californium	_
65 Tb	terbium 159	97	Æ	berkelium	_
64 Gd	gadolinium 157	96	Cm	curium	_
63 Eu	europium 152	92	Am	americium	_
62 Sm	samarium 150	94	Pu	plutonium	_
e1 Pm	promethium -	93	ď	neptunium	_
9 PX	neodymium 144	92	\supset	uranium	238
59 Pr	praseodymium 141	91	Ра	protactinium	231
Ce Ce	cerium 140	06	드	thorium	232
57 La	lanthanum 139	88	Ac	actinium	_

lanthanoids

actinoids

The volume of one mole of any gas is $24\,\mathrm{dm}^3$ at room temperature and pressure (r.t.p.).