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COMBINED SCIENCE

0653/31

Paper 3 Theory (Core)

May/June 2023

1 hour 15 minutes

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 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

1 (a) Fig. 1.1 shows the parts of an insect-pollinated flower.

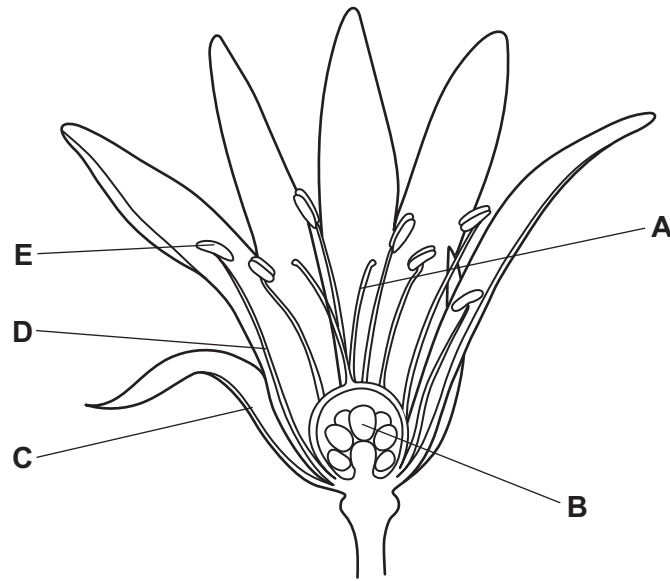


Fig. 1.1

- (i) State the letter in Fig. 1.1 that identifies the:
 sepal
 part where fertilisation occurs.

[2]

- (ii) State the **two** letters in Fig. 1.1 that identify the parts of the stamen.
 and

[1]

(b) Table 1.1 shows some information about the germination of seeds from different plants.

Table 1.1

plant seed	temperature range for germination /°C	number of days seeds take to germinate
bean	16 – 30	6 – 8
lettuce	2 – 21	3 – 5
onion	10 – 35	6 – 8
pea	4 – 24	6 – 8
pumpkin	21 – 32	4 – 6

(i) State the **minimum** number of days it takes for **all** of the seeds in Table 1.1 to germinate.

..... [1]

(ii) All the seeds are planted at a temperature of 18 °C.
After 10 days one type of plant seed did **not** germinate.

Use Table 1.1 to identify the type of plant seed that did not germinate.
Give a reason for your answer.

plant seed

reason

..... [2]

(iii) A suitable temperature is one environmental condition required for germination.

State one **other** environmental condition required for germination.

..... [1]

(c) When seeds germinate, the roots show gravitropism.

Complete the sentence to define gravitropism.

Gravitropism is a response in which plants grow towards or away from [1]

[Total: 8]

- 2 A student measures the melting point of some salty water and some pure water.

The results are shown in Table 2.1.

Table 2.1

	melting point /°C
salty water	-5
pure water	0

- (a) (i) State the name of **one** piece of apparatus that is used to measure temperature.

..... [1]

- (ii) State whether melting is a chemical change or a physical change.

Give a reason for your answer.

change

reason

.....

[1]

- (iii) The student also measures the boiling point of the two liquids.

State whether melting and boiling are endothermic or exothermic changes.

melting

boiling

[1]

- (b) Salty water contains salt dissolved in water.

State the method used to obtain pure water from salty water.

Explain your answer.

method

explanation

.....

.....

[2]

- (c) Pure water exists as a solid, as a liquid or as water vapour (a gas).

Complete Table 2.2 to describe the structure of solid water, liquid water and water vapour.

Table 2.2

	particle arrangement	particle separation	particle motion
solid water		close together	
liquid water			moving around
water vapour	random		

[3]

- (d) (i) Salt is a compound that is formed when atoms of sodium lose electrons and atoms of chlorine gain electrons.

State the name of the type of chemical bonding in sodium chloride.

..... [1]

- (ii) Water is a compound that is formed when hydrogen and oxygen, both non-metals, share electrons.

State the type of chemical bonding in water.

..... [1]

[Total: 10]

- 3 Fig. 3.1 shows a group of people keeping warm by a campfire and playing musical instruments.



Fig. 3.1

- (a) State the process that causes the hot smoke to move upwards from the fire.

..... [1]

- (b) A kettle filled with water is heated on the fire until it boils.

State the temperature of pure water when it is boiling.

temperature °C [1]

- (c) The air around the people is very cold.

- (i) State the process by which energy from the fire warms the people.

..... [1]

- (ii) State the part of the electromagnetic spectrum that transfers this energy.

..... [1]

(d) The people play musical instruments.

Table 3.1 shows the frequency ranges of the instruments they play.

Table 3.1

instrument	frequency range /Hz
clarinet	164 – 1567
flute	261 – 3349
French horn	110 – 880
guitar	82 – 880
trombone	85 – 493
trumpet	164 – 987
violin	196 – 3136

(i) Identify the instrument that can produce:

the note with the lowest pitch

the widest range of frequencies.

[2]

(ii) A bat flies past the campfire. The hearing range of the bat is from 2 kHz to 110 kHz.

State which **two** musical instruments can be heard by the bat.

..... and [1]

(e) A person at the campfire makes a mobile phone (cell phone) call.

State the part of the electromagnetic spectrum used to transmit the call using a mobile phone.

..... [1]

[Total: 8]

4 (a) Fig. 4.1 shows a model of the human gas exchange system.

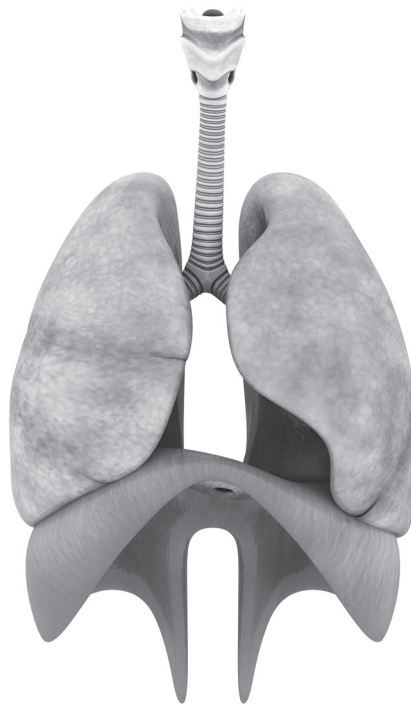


Fig. 4.1

Draw a label line and the letter **D** to identify the diaphragm on Fig. 4.1. [1]

(b) A student investigates the composition of expired air.

The student blows expired air into a test-tube containing limewater. The limewater turns cloudy.

State the name of the gas that turns the limewater cloudy.

..... [1]

(c) The gas exchange system is required for aerobic respiration.

State the word equation for aerobic respiration.

..... [2]

(d) The gas taken in by the lungs is transported around the body by the circulatory system.

(i) Complete the sentences about the circulatory system.

Use words from the list.

Each word or phrase may be used once, more than once or not at all.

- | | | |
|------------------------|--------------------------|------------------|
| artery | capillary | platelets |
| red blood cells | white blood cells | vein |

Blood is transported from the lungs to the heart in the pulmonary

The blood then leaves the heart in the main called the aorta.

Oxygen from the lungs is transported in the of the blood. [3]

(ii) State **two** ways the structure of a capillary is different from a vein.

1

2 [2]

[Total: 9]

- 5 (a) Ethane, C_2H_6 , is an alkane. It is one of the saturated hydrocarbons present in refinery gas obtained from petroleum, as shown in Fig. 5.1.

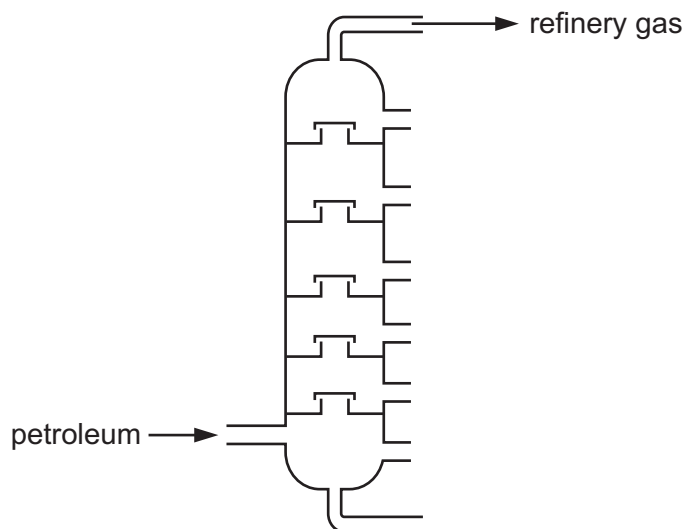


Fig. 5.1

- (i) State **one** use of refinery gas.

..... [1]

- (ii) Explain what is meant by hydrocarbon and saturated.

hydrocarbon

.....

saturated

.....

[2]

(b) Ethene, C₂H₄, is an unsaturated hydrocarbon.

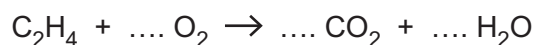
(i) State the process that produces unsaturated hydrocarbons from petroleum fractions.

..... [1]

(ii) Describe the change in colour of aqueous bromine when it is added to ethene.

from to [1]

(iii) Complete the balanced equation for the complete combustion of ethene.



[2]

(iv) State the name of the substance that is formed when many ethene monomer units join together.

..... [1]

[Total: 8]

- 6 Figure 6.1 shows a moving conveyor belt carrying a box from the ground up to an aircraft. The box weighs 500 N.

NOT TO SCALE

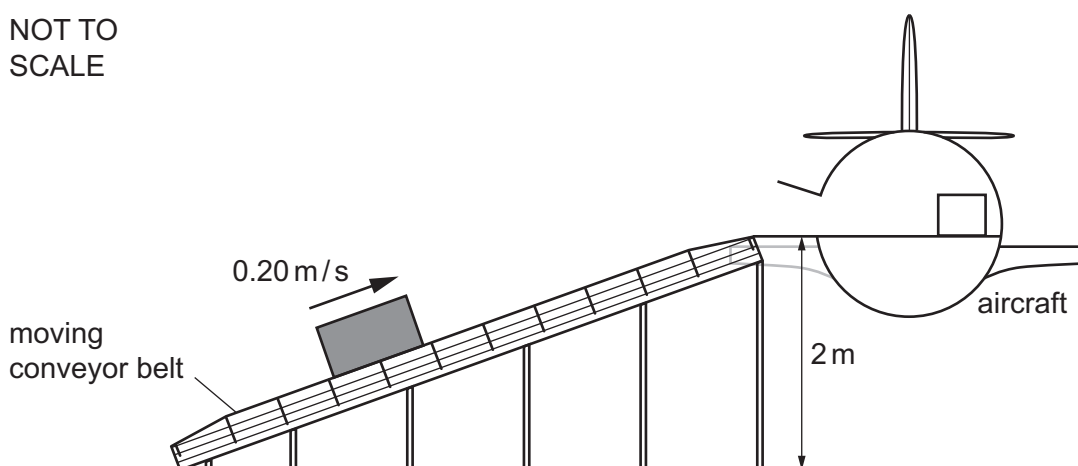


Fig. 6.1

- (a) (i) On Fig. 6.1, draw a force arrow to show the weight of the box. The arrow must be in contact with the box. [1]

- (ii) Complete the sentence.

The weight of the box is due to the force acting on the box. [1]

- (b) The conveyor belt carries the box at 0.20 m/s from the ground to the top in 25 s.

Calculate the length of the conveyor belt from the ground to the top.

length = m [2]

- (c) An electric motor drives the conveyor belt. Complete the sentences to describe the useful energy transfers.

The energy input to move the conveyor belt is energy.

This is transferred to energy of the moving conveyor belt and the box.

When the box stops at the top, it has gained energy. [3]

- (d) The conveyor belt stops for a short time when the box is only half-way to the top. The box stays at rest on the conveyor belt.

Explain in terms of the forces acting on the box, why the box stays at rest.

.....
..... [1]

- (e) When the box reaches the top, the box is stationary in the aircraft.

As a result of the work done, the box gains a total of 2.5 kJ of energy.

The total energy input to the electric motor doing this work is 90 kJ.

Explain the difference between these figures.

.....
..... [1]

[Total: 9]

- 7 (a) The leaves of some plants have green and white areas. Only the green areas of the leaf contain chlorophyll.

Fig. 7.1 shows a green and white leaf.

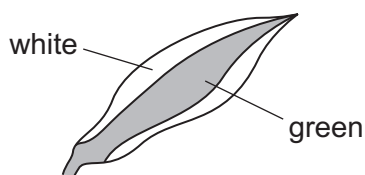


Fig. 7.1

Glucose from photosynthesis is stored as starch where it is made.

The leaf in Fig. 7.1 is tested for the presence of starch using iodine solution.

Fig. 7.2 shows some possible results.

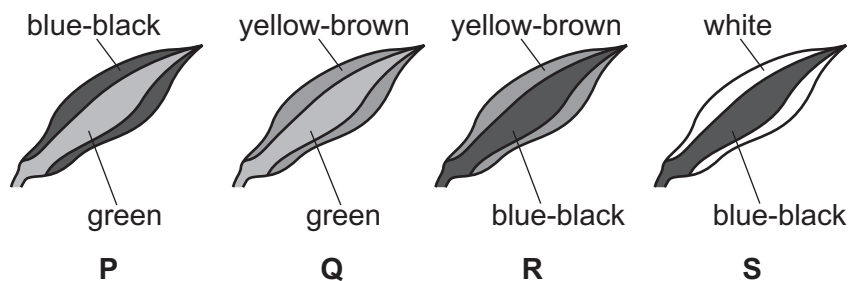


Fig. 7.2

- (i) Identify the letter of the correct result of the starch test in Fig. 7.2.

Give a reason for your answer.

letter

reason

.....

.....

[2]

- (ii) State the mineral ion needed by plants to keep leaves green.

..... [1]

(b) Transpiration involves the loss of water from leaves.

Tick (✓) **two** correct statements about transpiration.

Water evaporates from the surface of mesophyll cells.	
Water evaporates from the surface of cortex cells.	
Water evaporates from the surface of stomata.	
Water vapour diffuses through mesophyll cells.	
Water vapour diffuses through cortex cells.	
Water vapour diffuses through stomata.	

[2]

(c) The information in Fig. 7.3 describes some feeding relationships of living organisms in a habitat.

- | |
|---|
| <ul style="list-style-type: none"> • caterpillars eat flowers • owls eat snakes • frogs eat caterpillars • snakes eat frogs |
|---|

Fig. 7.3

(i) Draw a food chain using **all** the living organisms in Fig. 7.3.

..... [2]

(ii) Identify the **tertiary** consumer in Fig. 7.3.

..... [1]

(d) Two characteristics of living organisms are nutrition and respiration.

State two **other** characteristics of living organisms.

1

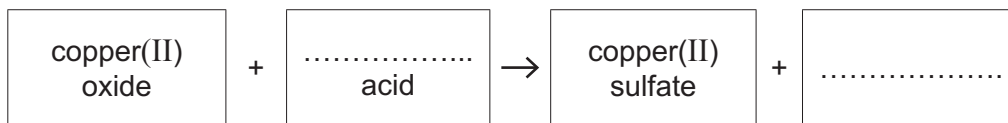
2

[2]

[Total: 10]

8 Copper(II) sulfate, CuSO_4 , can be made by reacting copper(II) oxide, CuO , with a dilute acid.

(a) (i) Complete the word equation for the formation of copper(II) sulfate from copper(II) oxide.



[1]

(ii) State **two** ways of increasing the rate of this reaction.

1

2

[2]

(b) (i) State the colour observed in the flame test of copper(II) ions, Cu^{2+} .

..... [1]

(ii) State the test for sulfate ions and the observation for a positive result.

test

.....

observation

[2]

(c) Copper atoms can have different numbers of neutrons.

One atom of copper is represented as shown.



Deduce the number of electrons and neutrons in this atom.

electrons

neutrons

[2]

[Total: 8]

- 9 Fig. 9.1 shows a student using a laptop computer. There is a lamp beside the student.



Fig. 9.1

- (a) The student sees the light from the lamp reflected in the computer screen.
Fig. 9.2 is a diagram of the student, lamp and computer from the same viewpoint as Fig. 9.1.

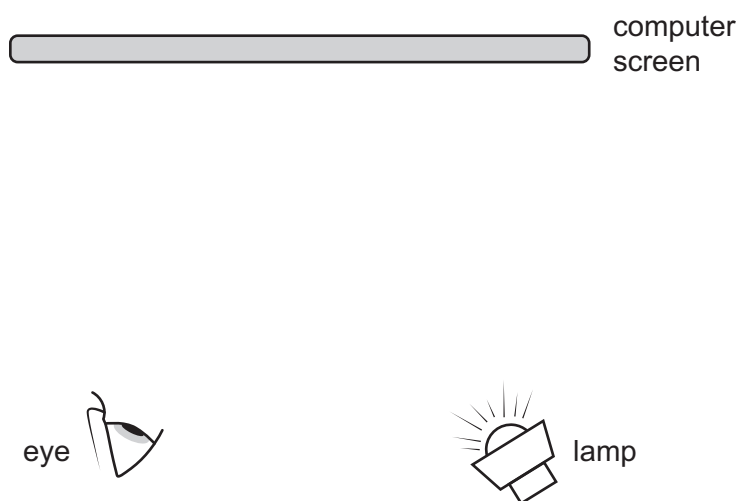


Fig. 9.2

On Fig. 9.2,

- Draw a ray from the lamp to the screen and the reflected ray to the student's eye.
- Draw and label the normal at the point of reflection.
- The ray you draw should follow the law of reflection at the screen.

[3]

- (b) The lamp is connected to the laptop computer by a cable with a switch. This supplies power to the lamp circuit at 5.0V.
The total resistance of the lamp circuit is 250Ω.

- (i) Calculate the current in the lamp circuit. Include the unit in your answer.

current = unit [3]

- (ii) The lamp circuit consists of a $70\ \Omega$ resistor and an LED (light-emitting diode) in series with the power supply.

Calculate the resistance of the LED.

resistance = Ω [2]

- (c) Use information from (b) to complete the circuit diagram for the lamp circuit. Draw the correct circuit symbols on Fig. 9.3.

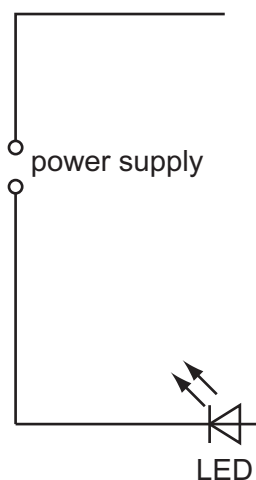


Fig. 9.3

[2]

[Total: 10]

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The Periodic Table of Elements

Group																																																																																																						
I	II	Key										III	IV	V	VI	VII	VIII																																																																																					
		atomic number atomic symbol name relative atomic mass																																																																																																				
3 Li lithium 7	4 Be beryllium 9	1 H hydrogen 1	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —	87 Fr francium —	88 Ra radium —	89–103 actinoids	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

lanthanoids

actinoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).