Cambridge Assessment International Education

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CO-ORDINATED SCIENCES **0654/32**

Paper 3 Theory (Core) **February/March 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.

This document has **28** pages. Any blank pages are indicated.

DC (LK/CB) 303335/4

1 **(a)** Table 1.1 shows the total number of teeth of different animals.

Table 1.1

animal	total number of teeth
elephant	26
fox	42
horse	40
human	32
mouse	18
sheep	32
tiger	30

(i) State which animal in Table 1.1 has the largest number of teeth.

..... [1]

(ii) Calculate the difference in the number of teeth between a human and an elephant as shown in Table 1.1.

..... [1]

(b) Circle the name of the outermost layer of a tooth.

cement **dentine** **enamel** **nerves** **pulp** [1]

(c) State the type of teeth responsible for grinding food.

..... [1]

(d) Describe **one** way to take care of teeth.

.....

..... [1]

(e) Fig. 1.1 is a diagram of the alimentary canal and associated organs in a human.

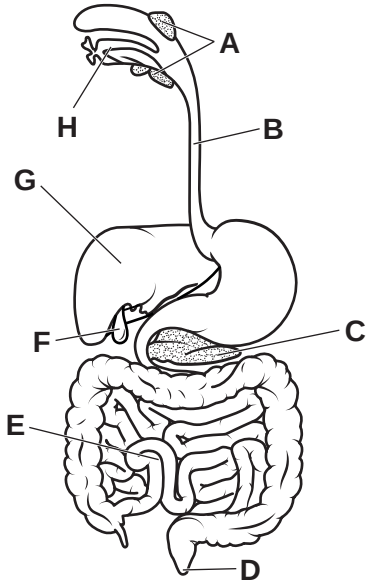

Fig. 1.1

(i) Identify the letter from Fig. 1.1 that represents where:

egestion occurs .....

the most absorption occurs .....

ingestion occurs. .....

[3]

(ii) State the name of part **C** in Fig. 1.1.

..... [1]

(f) Complete the definition of digestion.

Digestion is the ..... of large, insoluble food molecules into small, water-soluble molecules using ..... and chemical processes. [2]

(g) After the food is digested, nutrients pass into the blood.

State the part of the blood that transports soluble nutrients.

..... [1]

[Total: 12]

2 **(a)** Methane is a hydrocarbon.

(i) State what is meant by the term hydrocarbon.

.....

..... [2]

(ii) State the fossil fuel whose main constituent is methane.

..... [1]

(b) Complete the dot-and-cross diagram of a molecule of methane in Fig. 2.1.
Include the symbols for the chemical elements.

Show outer shell electrons only.

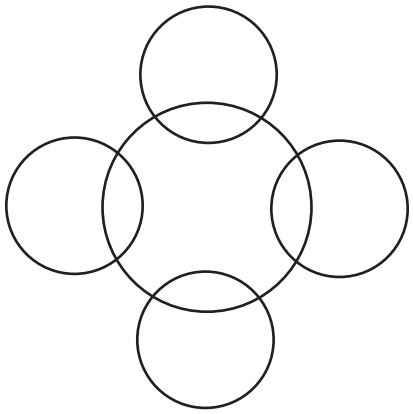

Fig. 2.1

[2]

(c) **(i)** The combustion of methane is an exothermic reaction.

State what is meant by exothermic.

.....

..... [1]

(ii) State the **two** products of the complete combustion of methane in oxygen.

1 .....

2 .....
[2]

(iii) During the incomplete combustion of methane, carbon monoxide is sometimes made.

Describe **one** adverse effect of carbon monoxide on the health of humans.

.....

..... [1]

(d) Ethane, C_2H_6, is an alkane. Ethene, C_2H_4, is an alkene.

(i) State the difference in structure between an alkane and an alkene.

..... [1]

(ii) Describe a chemical test that distinguishes between an alkane and an alkene.

Describe the observations for a positive result of the test in each case.

test .....

.....

for an alkane .....

.....

for an alkene .....

.....

[2]

[Total: 12]

3 Some examples of waves are listed.

γ-ray
infrared
microwave
radio
sound
visible light
X-ray

(a) Use words from the list to answer the following questions.

(i) State which wave in the electromagnetic spectrum has the highest frequency.

..... [1]

(ii) State which wave is emitted by a remote control for a television.

..... [1]

(b) Fig. 3.1 shows a ray of light passing through a rectangular glass block.

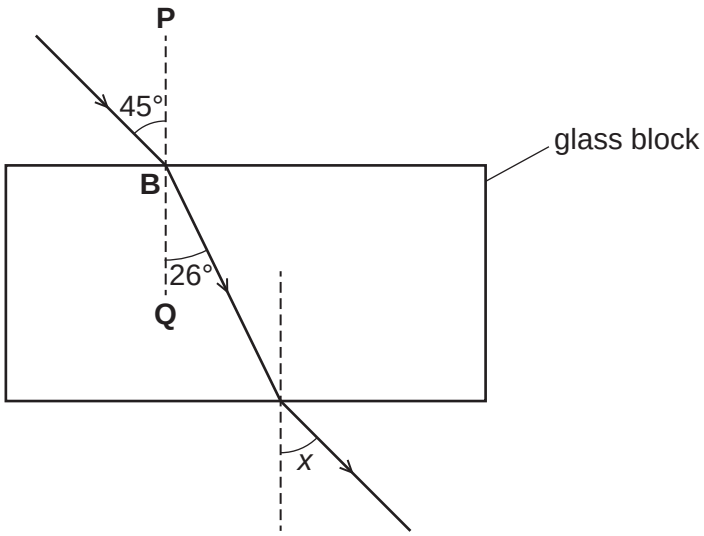

Fig. 3.1 (not to scale)

(i) State the effect shown by the ray of light at **B**.

..... [1]

(ii) State the name of the line labelled **PQ**.

..... [1]

(iii) State the value of angle *x*.

angle = ... ° [1]

(iv) The glass block in Fig. 3.1 is resting on a bench.

The glass block exerts a pressure on the bench.

State the **two** variables that must be measured to determine the pressure exerted.

1 .....

2 .....

[2]

(v) The mass of the glass block is 156 g.

The volume of the glass block is 60.0 cm^3.

Calculate the density of the glass block.

density = ... g/cm^3 [2]

(c) α-particles, β-particles and γ-rays are all types of ionising radiation.

(i) Place these **three** radiations in order of their ionising ability.

most ionising .....

.....

least ionising .....

[1]

(ii) State which **one** of these radiations is negatively charged.

..... [1]

(iii) State which **one** of these radiations is the most penetrating.

..... [1]

[Total: 12]

4 **(a)** Fig. 4.1 is a photograph of a dissected flower.

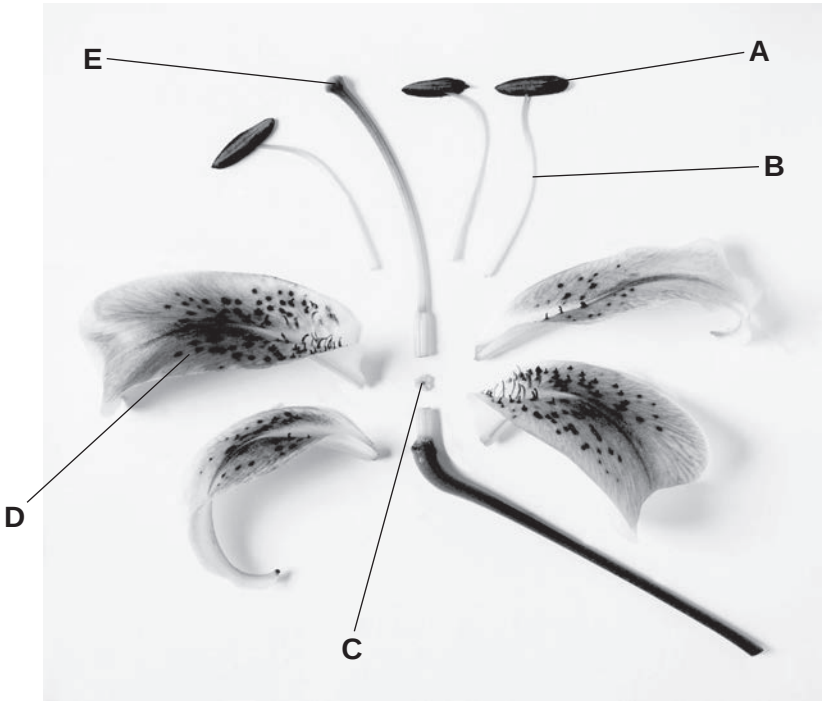

Fig. 4.1

(i) Table 4.1 shows the function of some of the parts labelled **A**–**E** in Fig. 4.1.

Complete Table 4.1.

Table 4.1

label from Fig. 4.1	function
	attracts pollinators
	where pollination occurs
	produces pollen

[3]

(ii) State the name of part **B** in Fig. 4.1.

..... [1]

(b) Complete the sentence to describe fertilisation in plants.

Fertilisation occurs when a pollen nucleus fuses with the nucleus in

the …..... . [1]

(c) Plants can reproduce asexually and sexually.

State **two** ways asexual reproduction is different from sexual reproduction.

1 .....

.....

2 .....

.....

[2]

(d) Reproduction is one of the characteristics of living organisms.

Tick (✓) **two** boxes that each show a characteristic of **all** living organisms.

breathing	
drinking	
eating	
excretion	
sensitivity	
sleeping	

[2]

[Total: 9]

5 **(a)** An atom of iron has a proton number of 26 and a nucleon number of 56.

(i) State the number of electrons in this atom of iron.

number of electrons = ... [1]

(ii) State the number of neutrons in this atom of iron.

number of neutrons = ... [1]

(iii) Another atom of iron has a nucleon number of 54.

State the proton number of this atom of iron.

proton number = ... [1]

(b) Fig. 5.1 shows an aqueous solution of iron(III) chloride.

Fig. 5.1

A student tests the solution to confirm that the label is correct.

State the test for aqueous iron(III) ions (Fe^{3+}) and give the observation for a positive result.

test .....

observation .....

.....
[2]

(c) Stainless steel is an alloy of iron.

(i) Define the term alloy.

.....

..... [1]

(ii) State **one** use for stainless steel.

..... [1]

(iii) State the **two** conditions needed for the rusting of iron.

1 .....

2 .....
[2]

(iv) Describe and explain **one** method of rust prevention.

.....

.....

..... [2]

[Total: 11]

6 **(a)** Fig. 6.1 shows two dolphins using sound waves to communicate with each other in the sea.

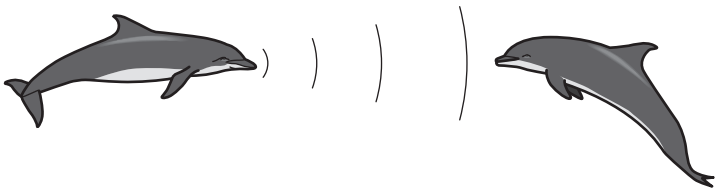

Fig. 6.1

(i) Dolphins hear sounds in the frequency range from 75 Hz to 100 000 Hz.

State why humans can hear some of these frequencies but not all of them.

Refer to the human audible frequency range in your answer.

.....

.....

..... [2]

(ii) A dolphin changes the frequency of a sound it makes from 1000 Hz to 2000 Hz.

State what happens to the pitch of the sound.

.....

..... [1]

(iii) The sound waves travel 80 m.

The speed of sound in water is 1600 m / s.

Calculate the time taken for a sound wave to travel 80 m in water.

time = ... s [2]

(b) Fig. 6.2 shows a speed–time graph for a dolphin travelling through water.

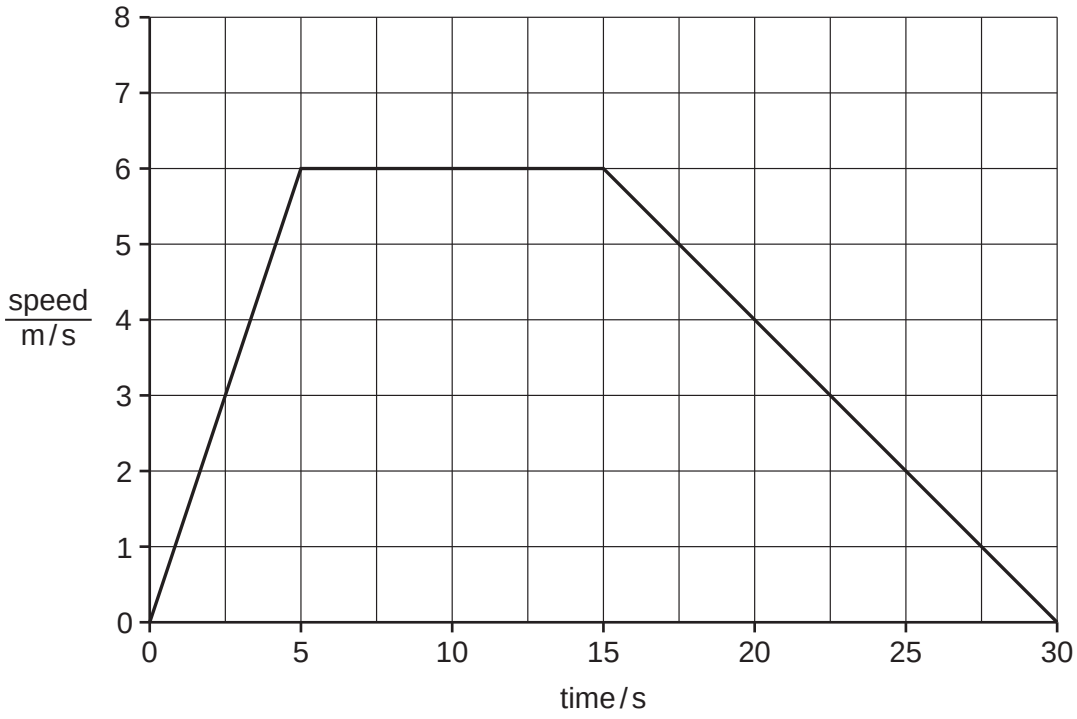

Fig. 6.2

(i) Describe the motion of the dolphin between time = 0 and time = 5 s.

.....

..... [1]

(ii) State the maximum speed of the dolphin as shown on the graph.

speed = ... m/s [1]

(iii) Calculate the distance travelled by the dolphin between time = 15 s and time = 30 s.

distance = ... m [2]

(c) The water in the sea is heated by the Sun.

Some molecules of water evaporate.

Describe the process of evaporation.

Use ideas about particles in your answer.

.....

.....

.....

..... [2]

[Total: 11]

7 Fig. 7.1 shows part of the carbon cycle.

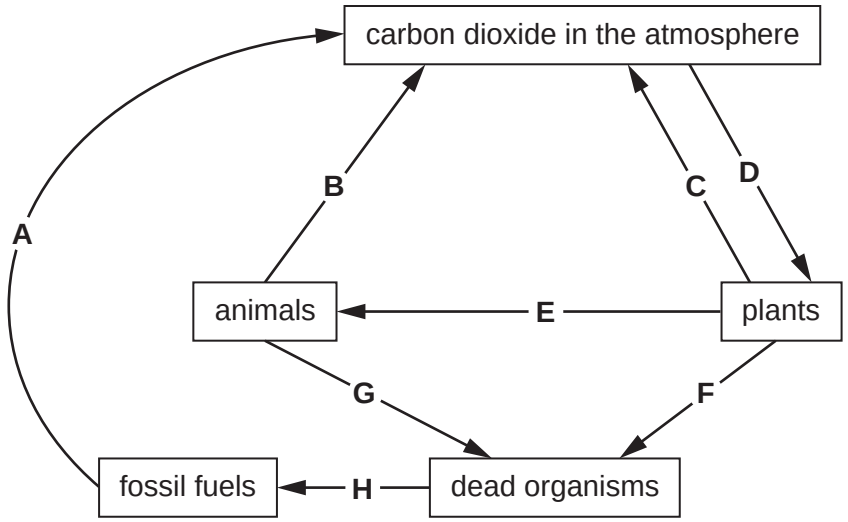

Fig. 7.1

(a) (i) Draw an arrow on Fig. 7.1 to represent the process of decomposition. [1]

(ii) Processes **B** and **C** are respiration.

Describe the process of respiration.

.....

.....

.....

.....

..... [3]

(b) Process **D** in Fig. 7.1 is photosynthesis.

State **three** requirements for photosynthesis.

1 .....

2 .....

3 .....

[3]

(c) Fig. 7.2 shows a food chain.

grass ⟶ sheep ⟶ fox ⟶ wolf

Fig. 7.2

(i) Circle the **two** words from the list that can be used to describe the sheep in Fig. 7.2.

carnivore **consumer** **decomposer**

herbivore **producer**

[2]

(ii) Identify the tertiary consumer in Fig. 7.2.

..... [1]

[Total: 10]

8 **(a)** Table 8.1 shows a list of covalently bonded molecules.

Table 8.1

molecule
Cl_2
CO_2
H_2
HCl
H_2O
NH_3

(i) Identify **two** molecules from Table 8.1 that are elements.

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

(ii) Identify **one** molecule from Table 8.1 that is diatomic.

..... [1]

(iii) Identify **one** molecule from Table 8.1 which is a greenhouse gas.

..... [1]

(b) **(i)** State the names of the **two** elements present in a molecule of ammonia, NH_3.

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

(ii) Determine the total number of atoms in a molecule of ammonia, NH_3.

..... [1]

(c) Water, H_2O, is a solvent.

State the meaning of the term solvent.

.....

..... [1]

(d) Dilute hydrochloric acid reacts with calcium carbonate to produce carbon dioxide, water and a solution of a salt.

(i) State which salt is produced.

..... [1]

(ii) Suggest a method of obtaining a sample of the dry salt from this salt solution.

..... [1]

(iii) When calcium carbonate and dilute hydrochloric acid react, the rate of reaction is slow.

Suggest **two** ways of **increasing** the rate of reaction.

1 .....

2 .....
[2]

[Total: 10]

9 Fig. 9.1 shows a refrigerator.

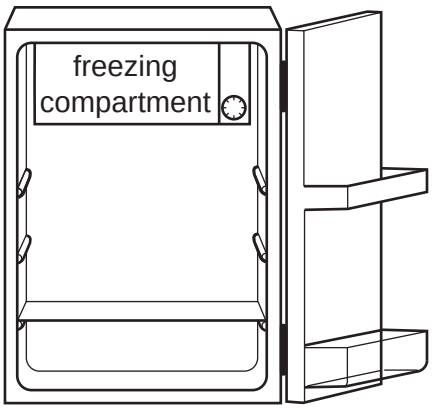

Fig. 9.1

(a) The air inside the refrigerator is cooled by the freezing compartment.

On Fig. 9.1, draw **one** straight arrow to show the movement of the air cooled by the freezing compartment. [1]

(b) Some ice is made from water in the freezing compartment.

Fig. 9.2 represents the arrangement of particles in a liquid and in a solid.

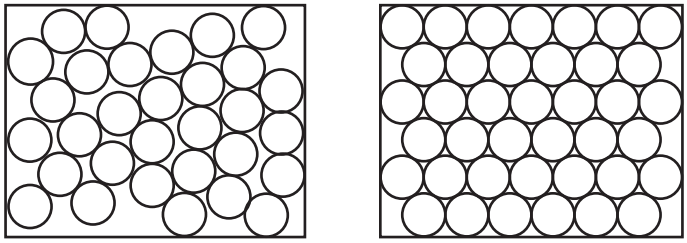

Fig. 9.2

Describe **two** differences between the particle arrangement in a liquid and in a solid as shown in Fig. 9.2.

1 .....

.....

2 .....

.....
[2]

(c) There is a lamp inside the refrigerator. The supply voltage is 240 V.

The current through the lamp is 0.04 A.

(i) Show that the resistance of the lamp is 6000 Ω.

[1]

(ii) Two lamps, each with a resistance of 6000 Ω, are connected in parallel.

The combined resistance of the two lamps is one of the following values.

3000 Ω 6000 Ω 12 000 Ω 24 000 Ω

State the correct value for the combined resistance.

Explain your answer.

resistance = ... Ω

explanation .....

.....

[2]

(d) The refrigerator has a d.c. motor.

The turning effect of the motor can be increased by increasing the strength of the magnetic field.

State **two** other ways to increase the turning effect of the motor.

1 .....

2 .....

[2]

[Total: 8]

10 (a) Fig. 10.1 is a diagram of a plant cell.

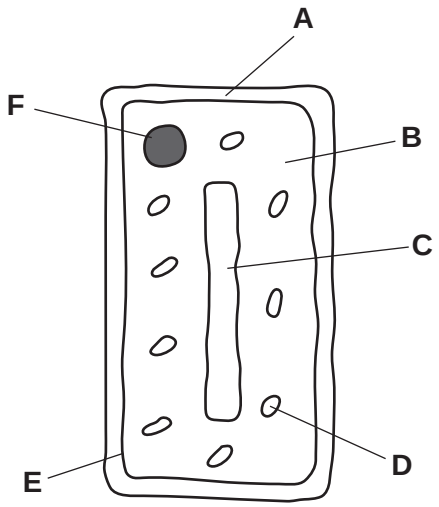

Fig. 10.1

(i) The boxes on the left show some labels from Fig. 10.1.

The boxes on the right show the names of some parts of a plant cell.

Draw lines to link each label with its correct name.

label from Fig. 10.1	**name of part**
	cell membrane
A	
	cell wall
C	
	chloroplast
D	
	vacuole

[3]

(ii) Identify **three** parts of a plant cell that are also found in an animal cell. Choose from the labels in Fig. 10.1.

1 ..... 2 ..... 3 .....

[2]

(iii) Describe **one** difference in structure between a root hair cell and the cell shown in Fig. 10.1.

.....

..... [1]

(iv) State **one** function of root hair cells.

.....

..... [1]

(b) A plant cell is 0.05 mm in length.

An animal cell is 0.02 mm in length.

Calculate how many times longer this plant cell is compared to this animal cell.

..... times longer [1]

(c) State which type of animal cell transports oxygen.

..... [1]

[Total: 9]

11 **(a)** Table 11.1 shows a list of seven metals from the Periodic Table.

Table 11.1

metal
calcium
copper
iron
lithium
magnesium
potassium
sodium

(i) Identify **three** metals from Table 11.1 that have only **one** electron in their outer shell as a neutral atom.

1 .....

2 .....

3 .....

[1]

(ii) Identify the **two** metals from Table 11.1 that are Group II metals.

1 .....

2 .....

[1]

(b) State **three** general physical properties that distinguish metals from non-metals.

1 .....

2 .....

3 .....

[3]

(c) Copper is used in electroplating.

Use words from the list to complete the description of electroplating.

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

electrode electrolyte negative neutral positive solute

Electrolysis is used to electroplate objects with copper.

The object to be plated, such as a metal pan, is connected to the ..... terminal of the power supply. This is called the cathode.

A piece of copper is connected to the ..... terminal. This is called the anode.

The anode and cathode are placed in aqueous copper(II) sulfate. This aqueous copper(II) sulfate is called the ..... .

[2]

[Total: 7]

12 **(a)** Fig. 12.1 shows **four** forces, *P*, *Q*, *R* and *S*, acting on a bus travelling along a level road at constant speed.

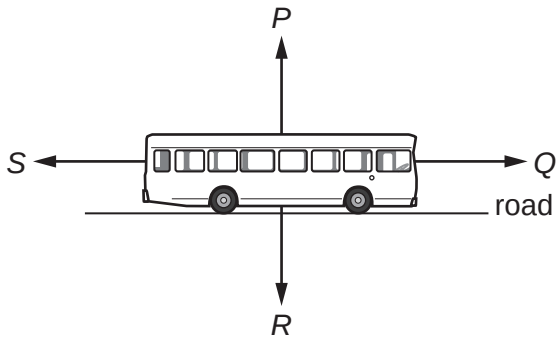

Fig. 12.1

(i) State which force is the weight of the bus.

force ..... [1]

(ii) Force *Q* is 500 000 N.

State the size of force *S*.

force *S* = ... N [1]

(b) The bus uses stored chemical energy from fuel to accelerate up a hill.

Some of this energy is transferred to thermal energy and sound energy.

State **two** other forms of energy transferred to the bus as it accelerates up the hill.

1 ..... energy

2 ..... energy

[2]

(c) The bus gets very hot on a sunny day.

State the method of thermal energy transfer between the Sun and the Earth.

..... [1]

(d) Some of the bus is made of iron. Other parts are made of steel.

Iron and steel are both magnetic.

Describe **one** difference between the magnetic properties of soft iron and the magnetic properties of steel.

.....

.....

..... [1]

(e) The fuel used by the bus is produced from petroleum.

Petroleum is a non-renewable energy source.

Name **one other** non-renewable energy source and **one** renewable energy source.

non-renewable energy source

.....

renewable energy source

..... [2]

(f) The air in the tyres of the bus warms up during a journey.

Describe how the motion of the molecules inside the tyres changes as the air warms up.

.....

..... [1]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											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	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	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	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
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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).