BOTSWANA EXAMINATIONS COUNCIL
Botswana General Certificate of Secondary Education

CANDIDATE NAME					
CENTRE NUMBER					
CANDIDATE NUMBER					

SCIENCE: DOUBLE AWARD **0569/03**

Paper 3 Theory **October/November 2021**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your candidate name, Centre number and candidate number in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do **not** use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.
You may lose marks if you do not show your working or if you do not use appropriate units.
You may use a calculator.

A copy of the Periodic Table is printed on page 20.

For Examiner's Use	
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14	
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This document consists of **18** printed pages and **2** blank pages.

[Turn over

For Examiner's Use

1 Fig. 1.1 shows the scale of a force meter used to measure the weight of a wooden block.

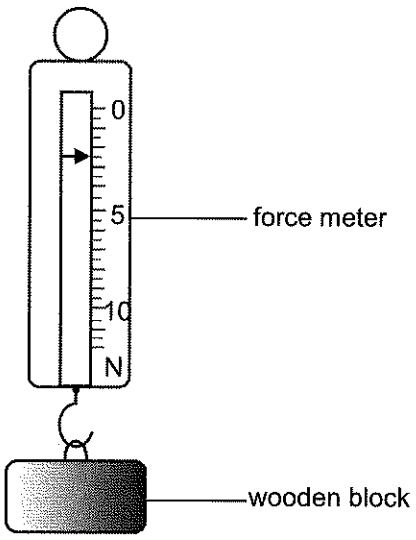


Fig. 1.1

(a) Define *weight*.

..... [1]

(b) Record the weight of the wooden block shown in Fig. 1.1.

weight = ... N [1]

(c) Calculate the mass of the wooden block. (g = 10 N/kg)

mass = ... [2]

(d) The wooden block is raised to a vertical height of 10 m above the ground.

Calculate the gravitational potential energy gained by the block. (g = 10 N/kg)

gravitational potential energy = ... [2]

2 Fig. 2.1 shows a pot used to boil water.

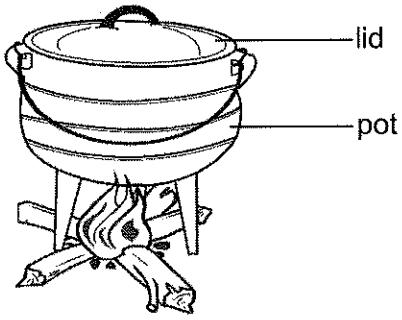


Fig. 2.1

(a) Define *boiling point*.

..... [1]

(b) Water droplets are seen underneath the lid when it is lifted.

Name the process that leads to formation of the water droplets.

..... [1]

(c) Complete Table 2.1 by stating **two** differences between boiling and evaporation.

Table 2.1

boiling	evaporation

[2]

(d) Thermal energy is transferred through the water inside the pot by convection.

Describe the process of convection.

.....

.....

.....

..... [3]

3 Fig. 3.1 shows a ray of light moving from air into a glass block at an angle of 55° from the normal line.
The angle of refraction is 33°. The diagram is not drawn to scale.

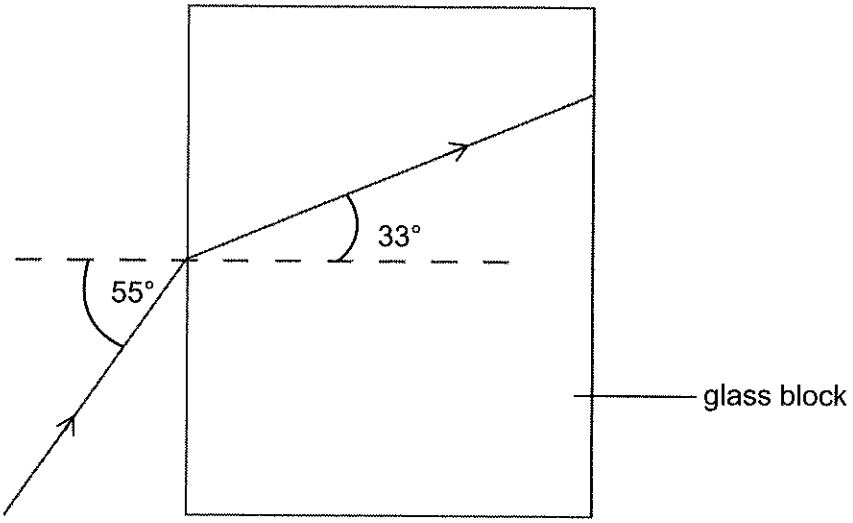


Fig. 3.1

(a) Give the meaning of angle of refraction.

.....

..... [1]

(b) Calculate the refractive index n of the glass block.

n =..... [2]

(c) The frequency of the light is 6.0×10^{14} Hz. The speed of light in air is 3×10^{8} m/s.

Calculate the wavelength of the light.

wavelength = ... [2]

(d) Name **two** regions of electromagnetic spectrum other than visible light.

1 .....

2 .....

[2]

4 **(a)** Fig. 4.1 shows a symbol of an electrical component.
Fig. 4.2 shows a voltmeter connected across the component.

Fig. 4.1

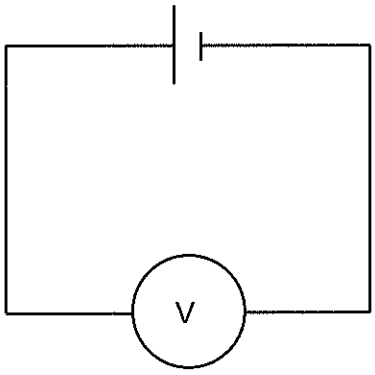


Fig. 4.2

(i) State the name of the component represented by the symbol in Fig. 4.1.

..... [1]

(ii) State the purpose of a voltmeter in an electrical circuit.

..... [1]

(b) Fig. 4.3 shows a circuit diagram.

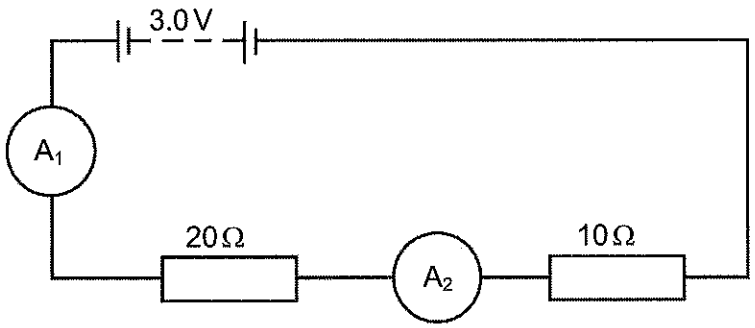


Fig. 4.3

The reading of ammeter A_1 is 0.10 A.

(i) Determine the reading of ammeter A_2.

reading =..... A [1]

(ii) Calculate the total resistance of the circuit.

total resistance = ... Ω [2]

(iii) Calculate the potential difference across the 10 Ω resistor.

potential difference = ... V [2]

5 Fig. 5.1 shows a transformer.

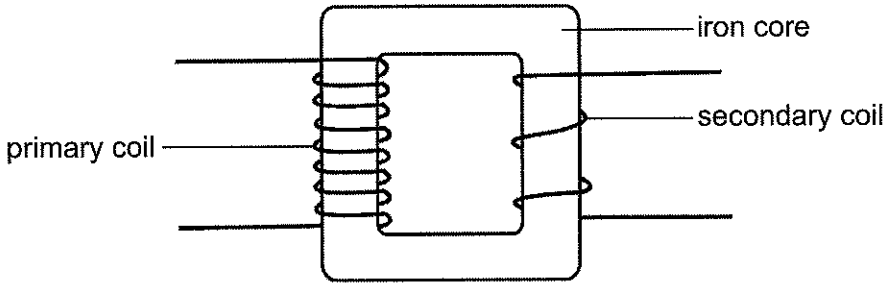


Fig. 5.1

(a) State the type of transformer shown in Fig. 5.1.

..... [1]

(b) The transformer has primary voltage of 220 V and secondary voltage of 6 V.
The number of turns in the primary coil is 1100.

Calculate the number of turns in the secondary coil.

number of turns in secondary = ... [2]

(c) Give a reason why electricity is transmitted from a power station to consumers at high voltage.

..... [1]

[Turn over

(d) Fig. 5.2 shows another transformer with a 12 V direct current connected to the primary coil. The switch S is closed and the pointer in the galvanometer deflects and rapidly returns to its original position.

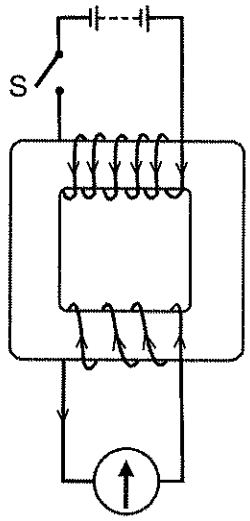


Fig. 5.2

Explain why the pointer deflects when the switch is closed.

.....

.....

.....

..... [3]

6 Choose from the substances listed to answer questions **(a)** to **(e)**.

fluorine **chlorine** **biogas** **calcium** **nitrogen dioxide**

ammonia **zinc** **petroleum** **tin** **copper**

Each substance can be used once, more than once or not at all.

State which substance

(a) most readily forms negative ions

.....

(b) is a component of both bronze and brass

.....

(c) is a non-renewable source of energy

.....

(d) does **not** react with cold water but reacts with steam

.....

(e) is a pollutant from car exhaust emission.

.....

[5]

7 The equation for the reaction of iron metal and oxygen is shown:

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

(a) Give the chemical name of Fe_2O_3.

..... [1]

(b) **(i)** State whether iron is oxidised.
Explain in terms of electrons.

.....

..... [1]

(ii) Iron acts as a reducing agent during the reaction.
Describe a chemical test to confirm that a solution contains a reducing agent.

test .....

result .....

.....
[2]

(c) In another reaction, iron reacts with aqueous copper(II) sulphate.
The equation for the reaction is shown.

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

(i) Name of the type of reaction.

..... [1]

(ii) State **two** observations that are made during the reaction.

1 .....

2 .....
[2]

8 Aspirin tablets contain acetylsalicylic acid.
Each aspirin tablet contains 0.300 g of acetylsalicylic acid.

(a) The molecular formula of acetylsalicylic acid is $C_9H_8O_4$.

(i) Calculate the relative molecular mass of acetylsalicylic acid.

relative molecular mass = ... [1]

(ii) Use your answer to **(a)(i)** to calculate the number of moles in 0.300 g of the acetylsalicylic acid.

number of moles = ... [2]

(b) A patient is recommended to take two aspirin tablets three times a day.

Use your answer to **(a)(ii)** to calculate the number of moles of the acid in the first dose of two aspirin tablets.

number of moles = ... [2]

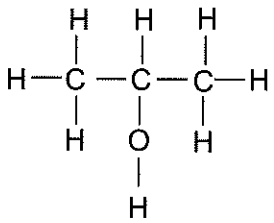
(c) The average volume of blood in an adult human body is 5.0 dm^3.

Use your answer to **(b)** to calculate the concentration of the acid in this volume of blood after taking two aspirin tablets.

concentration = ... [2]

[Turn over

9 A clinical disinfectant contains a compound X with the structure shown.



(a) Write the molecular formula of compound X.

..... [1]

(b) **(i)** Name the homologous series to which compound X belongs.

..... [1]

(ii) Write the general molecular formula of the homologous series to which compound X belongs.

..... [1]

(iii) Name the compound with 4 carbon atoms in the same homologous series as compound X.

..... [1]

(c) Compound X reacts with ethanoic acid, CH_3COOH, to form an ester.

(i) Draw the structure of the ester.

[2]

(ii) Name the type of macromolecule with the same type of linkage as the ester.

..... [1]

10 Vinegar contains ethanoic acid.
Ethanoic acid is a weak acid.

(a) (i) Explain the meaning of a weak acid.

.....

.....

..... [2]

(ii) Describe how it can be shown that ethanoic acid is a weak acid.

.....

.....

..... [2]

(b) Ethanoic acid, CH_3 COOH, reacts with aqueous sodium hydroxide to form salt and water.

(i) State the name of the salt formed.

..... [1]

(ii) Construct a balanced chemical equation for the reaction. Include state symbols.

..... [3]

For Examiner's Use

11 Fig 11.1 shows some parts of human cells and a neighbouring capillary.
The arrows show direction of movement of gases.

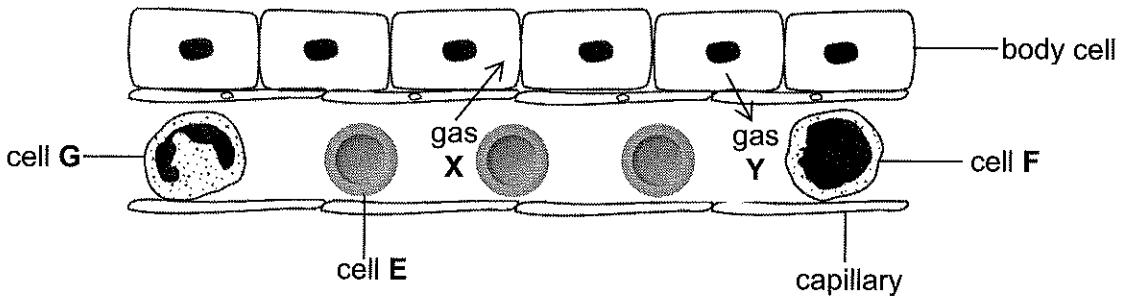


Fig. 11.1

(a) State the name of cell **E**.

..... [1]

(b) State the function of cell **F**.

..... [1]

(c) Give **two** structural differences between cell **E** and cell **G**.

cell **E**	cell **G**

[2]

(d) Describe how the capillary enables movement of gases **X** and **Y**.

.....

..... [2]

(e) Describe how gas **Y** is produced and removed from body cells.

.....

.....

.....

.....

.....

..... [4]

(f) Describe changes that occur in the blood as it goes through the kidney.

.....

.....

..... [2]

12 (a) State **two** properties of enzymes.

.....

..... [2]

(b) Describe chemical digestion of food in the following parts of the human digestive system.

(i) mouth.....

.....

..... [2]

(ii) stomach .....

.....

..... [2]

13 Fig. 13.1 is a graph showing concentration of hormones in the blood of a woman in a 28 day menstrual cycle.

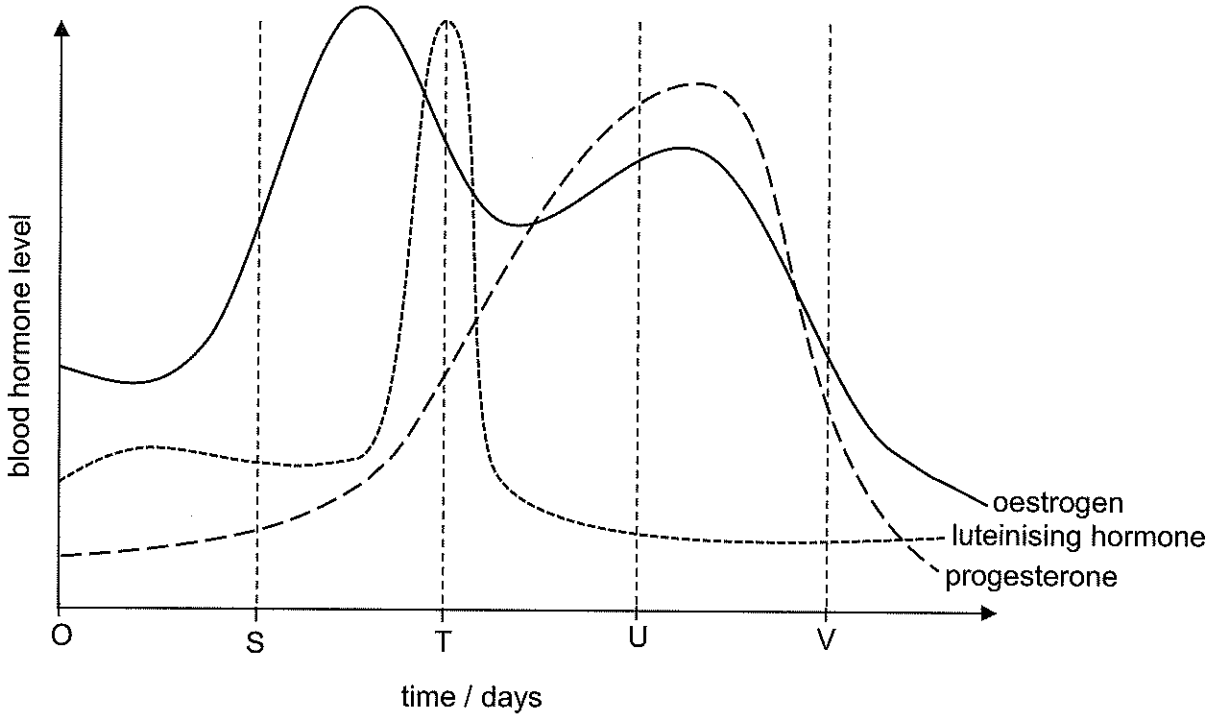


Fig. 13.1

(a) Name the gland that produces:

(i) oestrogen .....

(ii) luteinising hormone (LH) ..... [2]

(b) **(i)** Mark with a cross (x) the day at which fertilisation is **most** likely to occur. [1]

(ii) Explain your answer in **(b)(i)**.....

.....

..... [2]

(c) Explain the level of progesterone between regions T and V in Fig. 13.1

.....

..... [3]

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14 (a) Define pollution

.....

..... [1]

Fig.14.1 is a graph showing the effect of sewage disposal into a river.

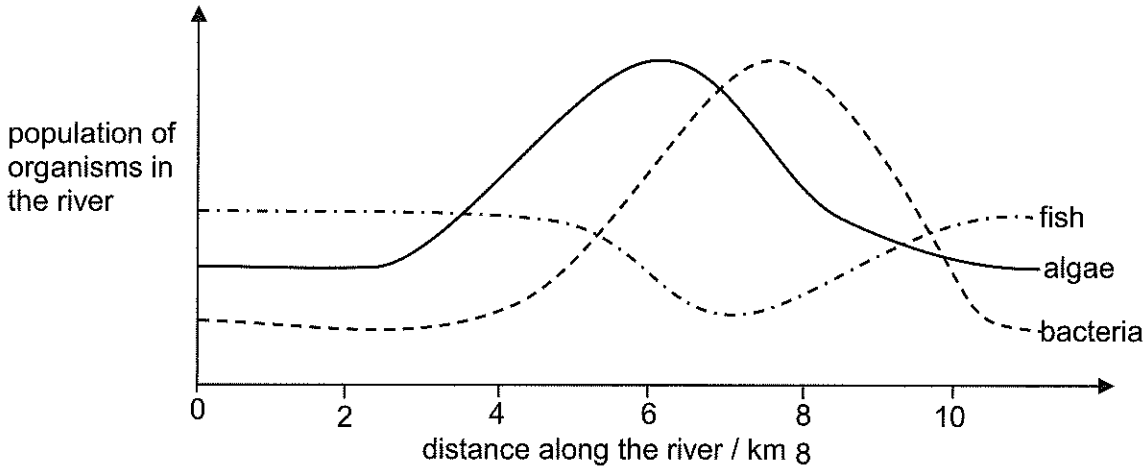

Fig. 14.1

(b) (i) Mark on the graph the point where sewage was disposed into the river.
Explain your answer.

.....

.....

..... [2]

(ii) Explain the shape of the graph for fish population between 4 and 8 km down the river.

.....

.....

.....

.....

.....

..... .[4]

(c) During expansion of a city, deforestation is done.
State **two** reasons why deforestation is considered harmful to the environment.

.....

.....

..... [2]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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