higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

MATERIAL TECHNOLOGY
NQF LEVEL 3

(6021013)

2 March 2018 (X-Paper)
09:00–12:00

This question paper consists of 8 pages.

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TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. ALL sketches must be neat, clear and in proportion.
5. Start new questions on a NEW page.
6. Write neatly and legibly.

NCV

QUESTION 1

1.1 Choose a description from COLUMN B that matches a word or term in COLUMN A. Write only the letter (A–O) next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	Corrosion	A	branch of science concerned with the properties of metals
1.1.2	Atom	B	chemical damage on surface of metal
1.1.3	Alloy	C	contains iron
1.1.4	Ferrous	D	hard, rough substance that forms on the surface of steel
1.1.5	Graphite	E	soft antifriction metal
1.1.6	Metallurgy	F	compound of oxygen and a metal
1.1.7	Scale	G	free from impurities or defects
1.1.8	Base metal	H	chemical element found in all living things
1.1.9	Mineral	I	principal constituent of an alloy
1.1.10	Refine	J	furnace used for the refining of metals
		K	grey, allotropic form of carbon
		L	smallest particle of any substance
		M	gas which assists combustion
		N	natural substance
		O	mixture of two or more metals

(10 × 1) (10)

1.2 Define the following mechanical properties of metals:

1.2.1 Brittleness

1.2.2 Ductility

1.2.3 Malleability

(3 × 2) (6)

1.3 Name THREE properties of high-carbon steel. (3)

1.4 Fully explain the effects that each of the following alloying materials has on the properties of the given base metal:

1.4.1 Alloying material – Tin
Base metal – Copper

1.4.2 Alloying material – Magnesium
Base metal – Aluminium

(2 × 3) (6)
[25]

QUESTION 2

2.1 State SEVEN general characteristics of non-metals. (7)

2.2 Vulcanisation is a chemical process used to convert rubber to a more durable material.

2.2.1 Explain the vulcanisation process. (3)

2.2.2 Discuss the effects that vulcanisation has on the properties of rubber. (4)

2.3 Non-metals are indicated by symbols and categorised in the periodic table (PT). Analyse the table below, and answer the questions. (Non-metals fall in the groups IIIA, IVA, VA, VIA, VIIA and O on the PT.)

NON-METAL	SYMBOL	GROUP CATEGORY IN PT
Boron	**(2.3.1)**	IIIA
Bromine	Br	**(2.3.2)**
Oxygen	O	**(2.3.3)**
Phosphorus	**(2.3.4)**	VA
Selenium	**(2.3.5)**	VIA
Sulphur	S	**(2.3.6)**
Tellurium	**(2.3.7)**	VIA

2.3.1 What is the symbol for boron as found in the PT?

2.3.2 In which group does bromine fall in the PT?

2.3.3 In which group does oxygen fall in the PT?

2.3.4 What is the symbol for phosphorus as found in the PT?

2.3.5 What is the symbol for selenium as found in the PT?

2.3.6 In which group does sulphur fall in the PT?

2.3.7 What is the symbol for tellurium as found in the PT?

(7 × 1) (7)

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2.4 Apart from acetal resins, name FOUR other thermoplastics. (4)
[25]

QUESTION 3

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1.1–3.1.7) in the ANSWER BOOK.

3.1.1 The cupola furnace produces high melting rates and is easy to operate.

3.1.2 The high pouring temperatures is a disadvantage of an arc furnace.

3.1.3 Coke is a type of carbon made from coal.

3.1.4 One of the advantages of tempering steel is that it releases the internal stress in the steel.

3.1.5 Carburising is the process by which carbon is introduced into a metal to harden the surface of the metal.

3.1.6 Annealing is a heat treatment technique that is mainly used to harden metals.

3.1.7 A blast furnace is used for the smelting of iron ore and transforming it into pig iron.

(7 × 1) (7)

3.2 The Bessemer process is a cost-effective process for the mass production of steel from pig iron.

3.2.1 What is the key principle of the Bessemer converter? (2)

3.2.2 Fully explain the working cycle of the Bessemer converter. (6)

3.3 The case-hardening of steel is a method used to harden the outer layer of steel with a low carbon content, but ensuring that the inner core of the steel is still soft and flexible.

3.3.1 In order to perform case-hardening on a piece of steel, what should the maximum percentage carbon content be in the steel? (1)

3.3.2 Fully explain the process you must follow to case-harden a piece of mild steel, ensuring that the finished product has a hard outer layer, but a soft and flexible inner core. (6)

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3.4 Three pictures of furnaces are shown in FIGURES 1, 2 and 3 below. Identify the furnaces by writing only the name of the furnace next to the question number (3.4.1–3.4.3) in the ANSWER BOOK.

3.4.1

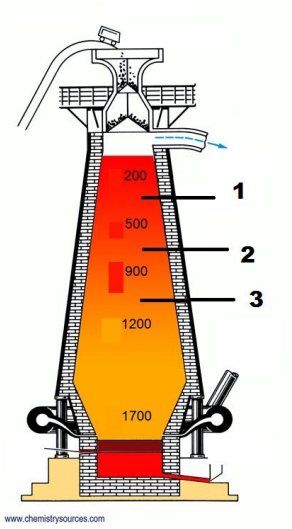

FIGURE 1

3.4.2

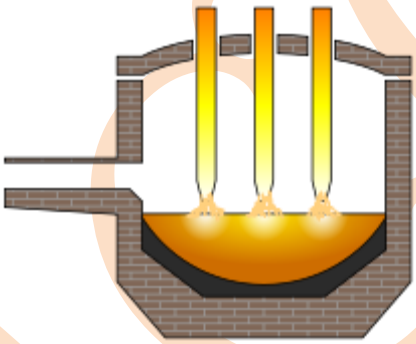

FIGURE 2

3.4.3

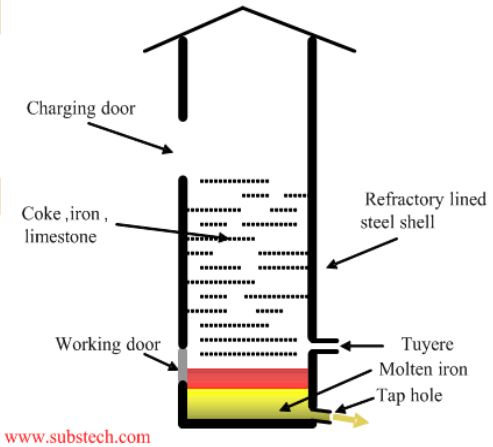

FIGURE 3

(3 × 1) (3)
[25]

QUESTION 4

4.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 The type of force used during a tensile test on a test piece is a ….. force.

A pulling
B pushing
C bending
D twisting

4.1.2 The Rockwell hardness value of diamonds is close to ...

A 526.
B 50.
C 1000.
D 2000.

4.1.3 The acronym VPN stands for ...

A Vickers Pyramid Number.
B Vickers Priority Number.
C Volume Pyramid Number.
D Volume Priority Number.

4.1.4 The hardness of tin can be measured using ONE of the following test methods:

A Rockwell only
B Vickers only
C Rockwell and Vickers
D Rockwell and Brinell

4.1.5 The formula $E = \frac{\sigma}{\varepsilon}$ is used to calculate ONE of the following:

A Strain
B Stress
C Young's modulus
D Tensile strength

(5 × 1) (5)

4.2 Define the following terms related to materials (an expression of the formulae will not be accepted):

4.2.1 Stress

4.2.2 Strain

(2 × 2) (4)

4.3 A piece of aluminium was tested in a Brinell hardness tester, using a 10 mm diameter ball. The tensile strength of the hardened test piece was found to be 243,41 MPa. The diameter of the impression was 2,88 mm.

Calculate the following:

4.3.1 The surface area of the impression in mm^2 to FOUR decimal places

4.3.2 The Brinell Hardness Number

4.3.3 The load applied by the tester in kg

(3 × 3) (9)

Given:

$$Surface\ area\ of\ impression = \frac{\pi D}{2}\left\{D - \sqrt{D^2 - d^2}\right\}$$

$$BHN = \frac{load\ kg}{curved\ surface\ area\ of\ indentation\ (mm^2)}$$

$$Tensile\ strength = 3{,}24 \times BHN$$

4.4 A force of 10 000 N was applied to a circular work-piece with a diameter of 20 mm.

Calculate the stress induced on the work-piece in MPa.

Given: $\sigma = \frac{F}{A}$ and $A = \frac{\pi}{4}D^2$ (4)

4.5 By means of sketches, indicate the direction in which the forces are applied when each of the following tests are performed on a rectangular work-piece:

4.5.1 Tensile test

4.5.2 Compressive test

4.5.3 Shear test

(3 × 1) (3)

[25]

TOTAL: 100

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