higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

MATERIAL TECHNOLOGY
NQF LEVEL 3

(6021013)

3 March 2020 (X-Paper)
09:00–12:00

This question paper consists of 8 pages.

227Q1S2003

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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. Clearly cross out all work you do not want to be marked.
5. Start each section on a new page.
6. Use only blue or black ink.
7. Write neatly and legibly.

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QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

1.1.1 Bronze is copper alloyed with tin.

1.1.2 The symbol for lead on the periodic table is Ld.

1.1.3 Lead has no resistance to corrosion when in contact with water.

1.1.4 Magnesium powder is highly flammable.

1.1.5 Magnesium is found in sea water.

1.1.6 Nickel cannot be used for electroplating.

1.1.7 The symbol for tin on the periodic table is Sn.

1.1.8 Tin is malleable and ductile.

1.1.9 Zinc is used for dry batteries.

1.1.10 Aluminium does not conduct electricity.

(10 × 1) (10)

1.2 Solid metals have lattice structures, such as the body-centred cubic (BCC) and face-centred cubic (FCC) lattices.

1.2.1 How many atoms does the BCC lattice have in its structure? (1)

1.2.2 How many atoms does the FCC lattice have in its structure? (1)

1.2.3 Molybdenum has a BCC lattice structure.

Name TWO other elements that have a BCC lattice structure. (2)

1.2.4 Aluminium has an FCC lattice structure.

Name TWO other elements that have an FCC lattice structure. (2)

1.3 Galvanising is a process where iron is covered with a protective layer of zinc.

1.3.1 Briefly explain why it is necessary to galvanise iron. (1)

1.3.2 Fully explain how zinc protects the iron from a corrosive medium after the iron has been galvanised. (4)

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1.4 Chromium is used as an alloying element in the production of stainless steel.

1.4.1 What is the symbol for chromium? (1)

1.4.2 Name THREE properties of chromium as an alloying element. (3)

[25]

QUESTION 2

2.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–K) next to the question number (2.1.1–2.1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1.1	Substance made of long molecular chains	A	grind
2.1.2	Ability to return to original shape	B	refine
2.1.3	Slows down or prevents reaction or process	C	molten
2.1.4	Glowing from heat	D	atom
2.1.5	Smallest particle of any substance	E	polymer
2.1.6	Reduce surface by abrasion	F	fibrous
2.1.7	Made liquid through heating	G	incandescent
2.1.8	Not allowing the passage of fluids or electric current	H	impermeable
2.1.9	Composed of threads	I	fused
2.1.10	To free a substance from impurities or defects	J	elasticity
		K	inhibitor

(10 × 1) (10)

2.2 Glass reinforced plastic (GRP) is a mixture of fibreglass and polyester resin used in various applications, such as household appliances and vehicle components.

2.2.1 State FOUR properties of GRP. (4)

2.2.2 Other than household appliances and vehicle components, name FOUR general uses of GRP. (NOTE: No marks will be allocated for household or vehicle components.) (4)

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2.3 Plastics can be classified into two different types, namely thermosetting plastics and thermoplastics.

2.3.1 State the main difference between *thermosetting plastics* and *thermoplastics*. (2)

2.3.2 Explain the thermoplastic cycle by means of a flow chart. (5)

[25]

QUESTION 3

3.1 Complete the following sentences by filling in the missing word from the list given below. Write only the word next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

refractory; carbon; tubes; base; standard; chrome; tuyeres; limestone; smelting; lining

3.1.1 Steel is mainly a mixture of … and iron.

3.1.2 Pig iron is used as the … metal in the production of wrought iron.

3.1.3 In the blast furnace, the ingredients in the smelting process are iron ore, … and coke.

3.1.4 The blast furnace is a large structure lined with firebricks, called ... bricks.

3.1.5 The blast furnace has nozzles called … through which hot air is forced into the furnace.

(5 × 1) (5)

3.2 The L-D converter is a process where low-phosphorus pig iron is converted into steel.

Fully explain the process that takes place when pig iron is converted into steel using the L-D converter. (8)

3.3 The Cupola furnace and the Arc furnace are used to produce steel. ONE of the advantages of these furnaces is that they have high melting rates.

3.3.1 State THREE other advantages of the Cupola furnace. (3)

3.3.2 State THREE other advantages of the Arc furnace. (3)

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3.4 When a piece of steel is heated to within the austenitic temperature range, it can be quenched to harden the steel by immediately placing the steel in cold water and rapidly moving it around in the water.

3.4.1 Should the heated steel be allowed to cool down slowly, will the cooled down steel be hardened or will it be soft again? (1)

3.4.2 Explain what metallurgical changes occur in the steel if it were not quenched rapidly and allowed to cool down slowly. (2)

3.4.3 Explain why it is necessary to move the heated steel rapidly around in the quenching liquid to ensure that it is quenched properly. (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 Which ONE of the following statements is not one of the purposes of testing materials?

A To assess the performance of the material
B To check for flaws in the material
C To reduce the quality of the material
D To measure properties, such as hardness, strength, et cetera

4.1.2 The Rockwell B scale uses a ... diameter hardened steel ball as an indenter.

A 16 mm
B 6,4 mm
C 3,2 mm
D 1,6 mm

4.1.3 What is the shape of the indenter used in the Brinell hardness tester?

A Diamond shape
B Conical shape
C Hexagonal shape
D Spherical shape

4.1.4 Using the Brinell hardness tester, what is the $\frac{F}{D^2}$ value used for testing copper?

A 30
B 5
C 10
D 1

4.1.5 When applying equal and exactly opposite forces to a body, the body tends to elongate or stretch.

What type of stress is induced in the body?

A Torsional stress
B Compressive stress
C Tensile stress
D Shear stress

(5 × 1) (5)

4.2 A test was conducted on a 12 mm test piece with a gauge length of 90 mm. The yield stress was found to be 689,6714 MPa and the maximum load was 102 kN. The percentage elongation of the test piece was found to be 23%. The diameter at fracture was 9,8 mm.

Calculate the following:

4.2.1 The force applied at the yield point in Kn (4)

4.2.2 The ultimate tensile strength of the test piece in MPa (3)

4.2.3 The final length of the test piece at the moment of fracture in mm (3)

4.2.4 The percentage reduction of area of the test piece (2)

Given: $\sigma_{Yield} = \frac{F_{Yield}}{A}$ and $\sigma_{Max} = \frac{F_{Max}}{A}$ and $A = \pi R^2 = \frac{\pi}{4} D^2$

$$\%\ Elongation = \frac{Elongation\ of\ gauge\ length}{Gauge\ length} \times 100$$

$$\%\ Reduction\ of\ Area = \frac{D^2 - d^2}{D^2} \times 100$$

4.3 Tensile forces acting on a 120 mm length test piece induced a maximum stress of 50 MPa in the test piece. The length of the test piece was extended by a certain amount during the test. The strain (ε) was found to be 0,05.

Calculate the following:

4.3.1 The change in length (ΔL) of the test piece in mm. (3)

4.3.2 Young's modulus of elasticity (E) for the material in MPa. (3)

4.3.3 If it is found that the ratio between the force and the stress was 1:100, calculate the original area of the test piece in m^2. (2)

Given: $\varepsilon = \frac{\Delta L}{L_o}$ *and* $\sigma = E.\varepsilon$ *and* $A = \frac{F}{\sigma}$

[25]

TOTAL: 100

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