THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

090 MECHANICAL ENGINEERING

Time: 2:30 Hours **ANSWERS** **Year: 2022**

Instructions

1. This paper consists of Section **A, B** and **C** with a total of **ten (10)** questions
2. Answer **al**l questions.
3. Section **A** and **C** carry **fifteen (15)** marks each and section **B** carries **seventy (70)** marks
4. Cellular phones and unauthorized materials are not allowed in the assessment room
5. Write your **Assessment Number** at the top right-hand corner of every page.

FOR ASSESSOR'S USE ONLY

QUESTION NUMBER	SCORE	ASSESSOR'S INITIALS
1		
2		
3		
4		
5		
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7		
8		
9		
10		
TOTAL		
CHECKER'S INITIALS		

SECTION A (15 Marks)

Answer all questions in this section.

1. Choose the correct answer from the given alternatives and write its letter in the box provided.

(i) Which materials are used to charge the blast furnace during the production of pig iron?

A. Coke, limestone and iron ore

B. Coke, limestone and slag

C. Steel scraps, limestone and coke

D. Limestone, air and pig iron

Blast furnaces are charged with coke (fuel), limestone (flux), and iron ore (raw material) to produce pig iron.

Answer: A

(ii) You are required to cut a thin metal using hacksaw. Suggest which hacksaw blade is appropriate to use.

A. Blades with tough teeth

B. Blades with elastic teeth

C. Blades with small pitch

D. Blades with large pitch

For thin metal, a blade with a small pitch (more teeth per inch) ensures finer, precise cuts without tearing.

Answer: C

(iii) Fixed, interlocking, automatic and trip guards are machine guards used to ensure safe work environment. Why most of the manufacturers prefer to use an interlocking safety guard than others?

A. It provides a tripping device inside the guard

B. It is operated by the moving part of the machine in which it is fitted

C. It forms an integral part of the machine and cannot be removed

D. It forms an integral part of the machine and can be removed

Interlocking guards stop the machine when opened, ensuring safety, and are integral but removable for maintenance.

Answer: D

(iv) Who is responsible to measure, analyze and interpret data for performance of mechanical components, device and engines in engineering field?

A. Technician

B. Technologist

C. Engineer

D. Artisan

Engineers are trained to measure, analyze, and interpret performance data for mechanical components and systems.

Answer: C

(v) What is the relationship between science and technology?

A. Technology is the application of science

B. Science is the application of science

C. Science is a major application of technology

D. Technology is the major application of science

Technology applies scientific knowledge to create practical solutions and innovations.

Answer: A

(vi) In gas welding, pressure regulators used have two gauges, what are the functions of the gauges?

A. To indicate working and gas content in the cylinder

B. To vary regulator pressure and cylinder pressure

C. To balance regulator pressure and cylinder pressure

D. To vary regulator pressure and maintain cylinder pressure

One gauge shows the cylinder's gas content (pressure), and the other shows the working pressure delivered to the torch.

Answer: A

(vii) Steel and cast iron are known as ferrous metals which are used in making different types of metallic components. What makes them different?

A. Sulphur content

B. Carbon content

C. Tungsten content

D. Oxygen content

The primary difference between steel and cast iron is their carbon content (steel: <2%, cast iron: >2%).

Answer: B

(viii) Which measuring instrument has features of try-square, bevel protractor, rule and scriber?

A. Depth gauge micrometer

B. Height gauge micrometer

C. Combination set

D. Inside micrometer

A combination set includes a try-square, bevel protractor, rule, and scriber for versatile measurements.

Answer: C

(ix) Which items are found in workshop first aid kit?

A. Pain killer tablets, ARVs, Bandage, Scissors and Tincture

B. Spirit, Syringe, TB tablets, Gloves and Bandages

C. Bandages, Scissors, Pain killer tablets, Tincture and Spirit

D. Condom, ARVs, TB tablets, Gloves and Spirit

A workshop first aid kit typically includes bandages, scissors, pain killer tablets, tincture, and spirit for treating minor injuries.

Answer: C

(x) The growth of industrial sector in Tanzania depends on the level of qualification to the workers. Who is responsible to perform routine product development and coordination of workforce, material and equipment?

A. An artisan

B. Craft person

C. Engineer technologist

D. Technician

An engineer technologist oversees product development and coordinates workforce, materials, and equipment in industrial settings.

Answer: C

2. Match the descriptions in List A with the corresponding term in List B by writing the letter of the correct answer in the table provided.

List A

(i) A thing or situation which may cause injury

(ii) An exposure to risk or chance to accident

(iii) A quality or condition of being safe from danger, injury or damage

(iv) State of sense of defence against attack

(v) An expected happening that results in injury

List B

A. Accident

B. Safe guard

C. Safety

D. Danger

E. Cautions

F. Security

G. Hazard

H. Precautions

(i) Thing/situation causing injury → G (Hazard)

(ii) Exposure to risk → D (Danger)

(iii) Being safe from danger → C (Safety)

(iv) Defence against attack → F (Security)

(v) Event resulting in injury → A (Accident)

SECTION B (70 Marks)

Answer all questions from this section.

3. You have been assigned to do laboratory analysis on white and malleable cast iron. The results observations were: increase of Ferrite phase, decrease of strength, toughness lowered and yield of strength.

(a) Which elements and their compositions were obtained in white cast iron? Give five elements.

(i) Carbon (3-4%)

(ii) Silicon (0.5-2%)

(iii) Manganese (0.2-0.8%)

(iv) Sulphur (0.1-0.3%)

(v) Phosphorus (0.1-0.2%)

(b) Briefly explain properties of malleable cast iron.

(i) High ductility due to nodular graphite structure.

(ii) Good toughness, resisting impact.

(iii) Moderate strength, suitable for load-bearing parts.

(iv) Machinability, allowing easy shaping.

(v) Corrosion resistance in certain environments.

(c) Where can white cast iron be used according to properties of white cast iron in analysis? Mention five uses.

(i) Brake shoes due to high hardness and wear resistance.

(ii) Mill liners for abrasion resistance.

(iii) Crusher jaws for crushing hard materials.

(iv) Pump housings for durability.

(v) Railcar wheels for wear resistance.

4. Figure 1 shows mechanical device commonly used in the workshop. Study it carefully and then answer the questions that follow:

Without the figure, assume a common workshop device like a bench vice.

(a) (i) Identify the component shown in Figure 1.

Bench Vice

(ii) What is the main function of the component?

To securely hold workpieces during cutting, drilling, or filing.

(b) Name the parts marked by letters A to E.

A. Fixed Jaw

B. Movable Jaw

C. Handle

D. Screw

E. Base

(c) (i) What type of materials is used to manufacture part D and E?

D (Screw): Steel

E (Base): Cast iron

(ii) Why part D is knurled on one side? Briefly explain.

Knurling provides grip for turning the screw to adjust the vice.

(iii) Why part D must be covered with soft plate liners?

Soft liners (e.g., rubber or copper) protect delicate workpieces from damage.

5. (a) Briefly explain the following terms as used in welding process.

(i) Arc crater: Depression at the weld's end due to arc termination.

(ii) Arc blow: Deflection of the arc by magnetic fields, causing uneven welding.

(iii) Welding polarity: Direction of current flow (e.g., DCSP or DCRP) affecting penetration.

(iv) Flux: Material that shields the weld, prevents oxidation, and stabilizes the arc.

(v) Arc length: Distance between electrode tip and workpiece, affecting weld quality.

(b) Suppose you are working in welding and metal fabrication workshop. What five exceptional precautions you should observe?

(i) Wear welding helmet to protect eyes from arc light.

(ii) Use gloves and apron to prevent burns.

(iii) Ensure proper ventilation to avoid fume inhalation.

(iv) Check equipment for gas leaks or electrical faults.

(v) Keep fire extinguisher nearby for emergencies.

6. Your school built a new welding and metal fabrication workshop. Why preventive measures are to be taken so as to prevent fire outbreak? Briefly explain using five points.

(a) Welding sparks can ignite flammable materials nearby.

(b) Gas leaks from cylinders may cause explosions.

(c) Overheated equipment can start fires.

(d) Improper storage of flammable substances increases risk.

(e) Electrical faults in welding machines may spark fires.

7. (a) You were assigned to cut various pieces of metal with hand hacksaw in the bench workshop. During the process you observe that, there were teeth breakages, excessive teeth wear and blade breakage. What are the two causes of these faults?

(i) Teeth breakages

Excessive pressure during cutting.

Incorrect blade tension.

(ii) Excessive teeth wear

Cutting hard materials with wrong blade type.

Improper cutting speed.

(iii) Blade breakage

Twisting blade during cutting.

Using a worn or defective blade.

(b) What are the four safety precautions which should be taken in order to avoid the situations observed in (a)?

(i) Use correct blade pitch for material.

(ii) Apply steady, moderate pressure while cutting.

(iii) Ensure proper blade tension before use.

(iv) Inspect blade for wear or damage before cutting.

8. What are the five advantages and five disadvantages of gas welding compared to other types?

Advantages

(i) Portable equipment, usable in remote locations.

(ii) Versatile for various metals and thicknesses.

(iii) Low equipment cost compared to arc welding.

(iv) Precise control over flame for delicate work.

(v) No need for electrical power supply.

Disadvantages

(i) Slower welding speed than arc welding.

(ii) Produces hazardous fumes requiring ventilation.

(iii) Limited to thinner materials.

(iv) High risk of fire from gas cylinders.

(v) Requires skilled operators for quality welds.

Disadvantages:

(i) Slow speed.

(ii) Hazardous fumes.

(iii) Limited to thin materials.

(iv) Fire risk.

(v) Needs skilled operators.

9. (a) Water, Foam and Carbon Dioxide (CO_2) are media used for fire extinguishers. Under which circumstance is it appropriate to use each media?

(i) Water: Class A fires (wood, paper, textiles); cools and soaks fuel.

(ii) Foam: Class A and B fires (flammable liquids); smothers and cools.

(iii) Carbon dioxide (CO_2): Class B and E fires (electrical, liquids); displaces oxygen.

(b) Suppose you are working in a mechanical workshop and you are required to arrange the materials using materials handling equipment such as forklift. Briefly explain four precautions you will take when handling mechanical equipment.

(i) Ensure operator is trained and certified.

(ii) Inspect forklift for defects before use.

(iii) Secure loads to prevent falling.

(iv) Avoid overloading beyond forklift capacity.

SECTION C (15 Marks)

Answer all questions.

10. A certain company decided to install a plant for iron and its product smelting from iron ores. They found out that there are Open hearth furnaces, Cupola furnace and Electric furnace.

(a) Giving a reason, advise the company management the type of furnace to install.

Electric furnace: Offers precise temperature control, high efficiency, and cleaner operation, ideal for producing high-quality steel and iron products.

Answer: Electric furnace: Precise, efficient, clean.

(b) What are the advantages of the furnace chosen in (a) when compared to others?

(i) High precision in temperature control.

(ii) Cleaner process with fewer emissions.

(iii) Energy-efficient, reducing operational costs.

(iv) Suitable for producing high-purity alloys.

(c) Pig iron production using cupola furnace may involve three main zones namely, combustion or oxidizing zone, reducing zone and melting zone. With the help of chemical reactions, describe the processes undergone in those zones.

(i) Combustion or oxidizing zone

Burning of coke with oxygen produces heat and carbon dioxide.

Chemical reaction: $C + O_2 \rightarrow CO_2$

(ii) Reducing zone

Carbon dioxide reacts with coke to form carbon monoxide, reducing iron oxides.

Chemical reaction: $CO_2 + C \rightarrow 2CO$

(iii) Melting zone

Iron ore melts, forming molten pig iron and slag with impurities.

Chemical reaction: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$