



ZIMBABWE

MINISTRY OF HIGHER AND TERTIARY EDUCATION

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**MOTOR MECHANICS, AUTOMOBILE ELECTRIC & ELECTRONICS,
DIESEL PLANT FITTING, VEHICLE BODY REPAIR, PRECISION
MACHINING AND MOTOR CYCLE MECHANIC**

**SUBJECT: Engineering Science and
Mathematics**

PAPER NO: 346/S03

OCTOBER/NOVEMBER 2012 EXAMINATION

REQUIREMENTS

**Answer Book, Graph paper, Scientific Calculator,
Drawing Instruments**

INSTRUCTIONS TO CANDIDATE

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|-------------------|--|-------------------|
| SECTION A: | Answer ALL questions. | (10 marks) |
| SECTION B: | Answer any FIVE (5) questions out of 7. | (30 marks) |
| SECTION C: | Answer ALL questions. | (10 marks) |
| SECTION D: | Answer any FIVE (5) questions out of 8. | (50 marks) |

This paper consists of 6 printed pages.

SECTION A

Answer ALL questions.

QUESTION 1

- 1.1 Convert $2 \times 5 . 136$ to denary (1 mark)
- 1.2 Express using formular: $P = V^2/R$
Evaluate the power correct to 2 decimal places given that
 $V = 24,62$ volts and $R = 45,21$ Ohms. (1 mark)
- 1.3 Factorise the following into two linear factors:
 $x^2 + 3x - 10$ (1 mark)
- 1.4 Evaluate $\log_3 27^{-1}$ (1 mark)
- 1.5 The major axis of an ellipse is 14.00cm and minor axis is 8.00cm.
Find the perimeter of the ellipse. (1 mark)
- 1.6 Determine the acute angle of arcsine 0.4529 (1 mark)
- 1.7 If $f(x) = 5x^2 - 3x + 1$ find $f(-2)$ (1 mark)
- 1.8 Find the gradient of a straight line AB, A(8:5), B(6:3) (1 mark)
- 1.9 Find the inverse matrix $A = \begin{pmatrix} 4 & -3 \\ 1 & 2 \end{pmatrix}$ (2 marks)

SECTION B

Answer any FIVE (5) questions.

QUESTION 2

2.1 ✓ Determine the remainder resulting from dividing. Use long division method $4x^3 + 13x + 33$ by $2x + 3$ (6 marks)

2.2 ✓ Solve the initial equation: $3^{x+1} = 2^{2x-3}$ correct to 2 decimal places. (6 marks)

2.3 The starting point of a hill-climb course has an angle of depression of 12 degrees when viewed from the finishing line which is 100 metres above the level of the starting point.

Find the distance of the course assuming that it is 12 per cent longer than the gradient. (6 marks)

2.4 a) Find the 1st derivative of $y = (\sqrt{x})^3 + \frac{1}{(\sqrt[3]{x})^5} + \frac{2x^7}{x^4} + 2$ (3 marks)

b) Differentiate $y = 5$ from 1st principle (3 marks)

2.5 a) $\int x^7 dx$ (1 mark)

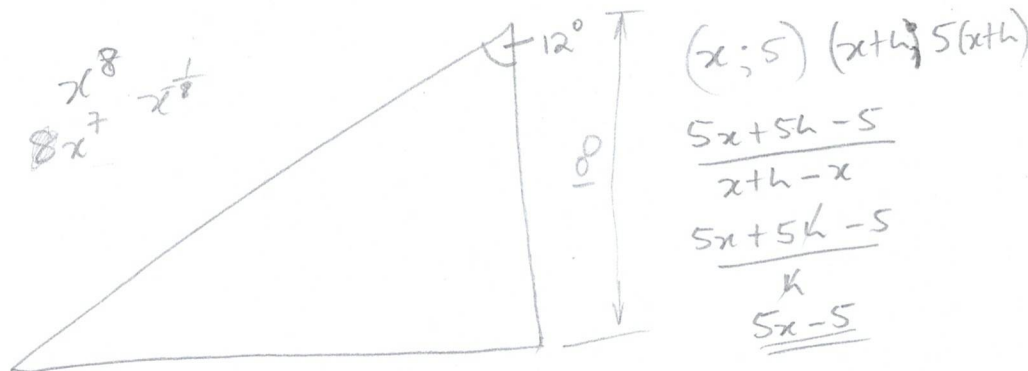
b) $\int \sqrt{x} dx$ (2 marks)

c) Determine the value of $3x + 4 - \frac{5}{x}$ as x increases from -1 to 3 (3 marks)

2.6 Evaluate the determinant:

$$\begin{vmatrix} 1 & 3 & 2 \\ 4 & 5 & 7 \\ 2 & 4 & 8 \end{vmatrix} \quad (6 \text{ marks})$$

2.7 ✓ Find the vector product of $\vec{P}$ and $\vec{Q}$ where $\vec{P} = 3\mathbf{i} - 4\mathbf{j} + 2\mathbf{k}$ and $\vec{Q} = 2\mathbf{i} + 5\mathbf{j} - 1\mathbf{k}$ (6 marks)



SECTION C

Answer ALL questions.

QUESTION 3

- 3.1 Express in radians 180° (1 mark)
- 3.2 Define Kinetics (1 mark)
- 3.3 Determine the gravitational force acting on a body of mass 160kg. (1 mark)
- 3.4 State formular for momentum. (1 mark)
- 3.5 Define tractive effort. (1 mark)
- 3.6 What is work? (1 mark)
- 3.7 The boiling point of oxygen at normal atmospheric pressure is 90K. Convert this temperature into degrees Celsius. (1 mark)
- 3.8 The friction disc of a single-plate clutch has a face area of 0.025m^2 and a mean radius of 0.12m. If the spring force per m^2 of area is not to exceed 120KN, and the coefficient of friction between the lining material and the driving surface is 0.3, calculate the maximum torque transmitted by clutch. (2 marks)
- 3.9 Define ductility. (1 mark)

$A = 0.025$
 $R = 0.12$
 $n = 2$
 $\mu = 0.3$

SECTION D

Answer any FIVE (5) questions.

QUESTION 4

A vehicle has a wheelbase of 2.4m, a total mass of 2 tonne and the road wheels are 0.6m in diameter. When the rear axle is raised, the distance of the c.g. from the rear axle is 7.5m. The mass of the rear axle is 1.15 tonne and the mass on the front axle is 0.85 tonne. Determine the height of the c.g. above the ground level. (10 marks)

~~X~~ QUESTION 5

A hollow cast Iron Column of cross section 2.2m long has its internal sides measuring 150mm and is to carry a load of 1MN. If the safe working stress is to be limited to 120MN/m^2 , Calculate:

- a) The area of the metal required the Load? (3 marks)
- b) The thickness of walls of column (4 marks)
- c) If the value of E of the material is 120GN/m^2 , by how much will the column shorten under the load of 1MN. (3 marks)

QUESTION 6

A hydraulic press is operated by a force of 265N applied perpendicular to the end of a Lever. The lever ratio is 15 to 1. The pumping plunger is 25mm diameter and its stroke is 50mm. The ram is 200mm in diameter. Neglect friction, find:

- a) The load on the press (5 marks)
- b) The number of pumping strokes required to move the ram 50mm. (5 marks)

~~*~~ QUESTION 7 ✓

A steel component having a mass of 20kg and a temperature of 700°C is dropped into a tank containing 40kg of water at 15°C . Neglecting the heat energy absorbed by the tank and any loss of heat energy to the surrounding air, determine:

- a) The final temperature of water (6 marks)
- b) Heat energy absorbed by the water (4 marks)

Take specific heat capacity of steel and water as 0.48KJ/Kg K and 4.2KJ/Kg K respectively.

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*QUESTION 8

A pressure of 965 kN/m^2 acts vertically downward on a piston crown, the piston is 72.5 mm diameter. The angle of connecting rod causes a side thrust of 1555 N on the piston. Construct a space and force diagram to determine the thrust along the connecting rod and its angle in relation to cylinder bore axis. (10 marks)

QUESTION 9

A screw jack has a thread of 6 mm pitch. An effort of 80 N applied at a radius of 420 mm is just sufficient to move a load of 8.8 kN . Calculate:

- VR
- b) The efficiency of the jack ✓
 - b) Work done on the load to raise it by 50 mm . ✓
 - c) Work done in overcoming friction when raising the load (10 marks)
- 2520

*QUESTION 10 ✓

A body moves with uniform acceleration.

- b) If the body velocity increases from 4 m/s to 25 m/s in 3.2 sec . Calculate the acceleration and the distance covered in this time. (5 marks)
- b) If with an initial velocity of 4 m/s covers a distance of 32 m in 4.5 sec , determine the new acceleration and the final velocity. (5 marks)

*QUESTION 11 ✓

A uniform beam AB of 6 m length is simply supported on its ends. It carries point loads 200 N , 400 N and 300 N at distances of 1.5 m , 3 m , and 5 m respectively from A. Determine the magnitude of the reaction at A and B. (10 marks)

VR

...../ab

$$0,25 = \frac{110}{x}$$

$$\frac{x}{6} = 440$$