



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**MOTOR VEHICLE MECHANICS, AUTO-ELECTRICS, DPF, MVBR,
PRECISION MACHINISTS, MOTOR CYCLE MECHANICS**

**SUBJECT: Engineering Science and
Mathematics**

PAPER NO: 346/S03

DURATION: 3 Hours

OCTOBER/NOVEMBER 2015 EXAMINATION

REQUIREMENTS

Scientific Calculator

INSTRUCTIONS TO CANDIDATE

1. SECTION A: Answer ALL questions.
2. SECTION B: Answer any FIVE (5) questions.
3. SECTION C: Answer ALL questions.
4. SECTION D: Answer any FIVE (5) questions.

This paper consists of 5 printed pages.

SECTION A

Answer ALL questions.

QUESTION 1

- a) Factorise completely $20x^2 - 45$ (1 mark)
- b) Evaluate $(a^{\circ} b^2 c)^{-2}$ (1 mark)
- c) Find the radius of a circle if its perimeter is 54cm (1 mark)
- d) Make E subject of the formula in $\frac{x+y}{E^2} = \frac{x^2+3x-4y}{x-y}$ (1 mark)
- e) Integrate with respect to x: $x^2 + 2x + 3$ (1 mark)
- f) Given that $\log 2 = 0.301$ and $\log 3 = 0.477$, find $\log 2^{7/9}$ (1 mark)
- g) Convert the following to base 2 346 (1 mark)
- h) Write the following number in preferred standard form 46 082 (1 mark)
- i) If matrix $A = \begin{bmatrix} -2 & -47 \\ 8 & -113 \end{bmatrix}$ Find $3A$ (1 mark)
- j) $A = -3i - 4j$
 $B = 8i + 12j$
 Find $B - A$ (1 mark)

SECTION B

Answer any FIVE (5) questions.

QUESTION 2

- a) Find the product of: $\begin{bmatrix} 4 & 7 & 6 \\ 2 & 3 & 1 \end{bmatrix} \begin{bmatrix} 8 \\ 5 \\ 9 \end{bmatrix}$ (6 marks)
- b) Nest the following polynomial $f(x) = 4x^4 - 6x^3 + 11x^2 - 7x + 2$
 $f(2) =$ (6 marks)
- c) Solve for $\log_4 = 1/256$ (6 marks)
- d) i) If $y = 2x^2 + 5$. Find the gradient when $x = 1.5$ (3 marks)
- ii) $\left(\frac{1}{\sqrt{x}}\right)^5$ (3 marks)

- e) The gradient function of a curve passing through a point (2:4) is $4x^2 + 9$. Find the equation of the curve. (6 marks)
- f) Vector $\vec{a} = 3i - 4j + 6k$
 $\vec{b} = -5i + 11j - 12k$
 $\vec{c} = 3i + 7j$
- i) Find $|A + B|$ (2 marks)
- ii) Direction of vector c (2 marks)
- iii) $\vec{C} - \vec{B}$ (2 marks)
- g) An engine has a 88mm stroke and the connecting rod is 175mm long between bearing centres. Assume that the piston has travelled 19mm down the bore from t.d.c. Calculate:
- i) The angle between the crank and the connecting rod (3 marks)
- ii) The crank angle from t.d.c (3 marks)

SECTION C

Answer ALL questions.

QUESTION 3

- a) What kind of stress would a cylinder head gasket of a motor vehicle be subjected to when under normal operation? (1 mark)
- b) Give one characteristic of a common lever. (1 mark)
- c) Give effect of friction in a journal bearing (1 mark)
- d) Define convention (1 mark)
- e) Calculate work done when a casting is moving 15m along a workshop floor by a force of 7.5kN (1 mark)
- f) State parallelogram of forces (2 marks)
- g) Give units of angular velocity (1 mark)
- h) Define:
- i) Brake Power (1 mark)
- ii) Indicated Power (1 mark)

SECTION D**Answer any FIVE (5) questions.**QUESTION 4

A tensile force of 10kN is applied to a round steel bar with a diameter of 20mm and a length of 2m. Young's modulus of elasticity for this steel is 2000GPa. Calculate:

- a) Stress (5 marks)
 b) The extension due to the tensile force (5 marks)

QUESTION 5

The distance S metres of a body travelling with constant acceleration a m/s² in a straight line is given by $S = ut + \frac{1}{2}at^2$ where u m/s is the initial velocity and t seconds the time. Calculate the initial velocity and the acceleration given that $S = 36m$ at $t = 2s$ and $S = 124m$ when $t = 4s$ (10 marks)

QUESTION 6

- a) Calculate the heat energy required to melt completely 4kg of a copper alloy initially at a temperature of 80°C melting point of the alloy 1080°C specific heat capacity of the alloy = 0.4KJ/KgK specific latent heat of fusion of the alloy 210KJ/Kg. (6 marks)
- b) An exhaust from pipe is 1.5m long at 20°C. What will be its length when its temperature is raised to 370°C? The coefficient of linear expansion of the steel used is $12 \times 10^{-6}/K$ (4 marks)

QUESTION 7

Using a dynamometer having a torque arm length of 0.5m, the following brake loads were obtained during a Morse test on a test speed of 2520 rev/min:

Cylinder Firing	All Four	Nos 2;3;4	Nos 1;3;4	Nos 1;2;4	Nos 1;2;3
Brake Force (N)	180	118	125	127	121

Calculate:

- a) Brake Power (4 marks)
 b) Indicated Power (6 marks)

QUESTION 8

The beam of the car lift is 4m long and the vehicle has the following wheel loads, 1500kg front and 2500kg rear. The front wheel is positioned at a distance of 0.4m from one end of the beam and the wheelbase of the vehicle is 2.2m. Calculate the values of reactions at the beam supports. (10 marks)

QUESTION 9

A journal 0.052m diameter carries a total load of 11 120N and makes 260rev/min. The coefficient of friction is 0.03. Calculate:

- a) The frictional torque
 - b) The workdone against friction per minute
 - c) The heat generated per minute at the bearing
- (10 marks)

QUESTION 10

A hydraulic press is operated by a force of 265N applied perpendicular to the end of a lever. The lever ratio is 15:1. 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 11

A vehicle of mass 600kg being propelled up a hill gradient 1:15 at a speed 81km/h. Find the work done against gravity per minute. Neglect frictional resistance. (6 marks)

A truck weighing 2 tonnes is travelling at a speed of 50km/h. Determine the kinetic energy of the truck at this speed. (4 marks)

.../ab