



ZIMBABWE

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

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**MACHINESHOP, FABRICATION, REFRIGERATION AND AIR CONDITIONING,
VBB, FOUNDRY , DDT, PPO, TG**

SUBJECT: Engineering Science

PAPER NO: 340/13/S03

DURATION: 3 hours

MARCH/APRIL 2020 EXAMINATION

REQUIREMENTS

1. Answer booklet.
2. Non-programmable scientific calculator.

INSTRUCTIONS TO CANDIDATE

1. Answer all the parts of question 1 in Section A. Each part carries 5 marks.
2. Answer any four (4) questions in Section B. Each question carries 15 marks.

This paper consists of 5 printed pages.

SECTION A

QUESTION 1

1.1 Convert the following:

- i) 0.7N/mm^2 to MPa (1 mark)
- ii) 25km/hr to m/s (1 mark)
- iii) $15.5\mu\text{N}$ to KN (1 mark)
- iv) 800 rev/min to rad/s (1 mark)
- v) 215.5°C to Kelvin (1 mark)

1.2 Define the following terms:

- i) Power (1 mark)
- ii) Mass (1 mark)
- iii) Pressure (1 mark)
- iv) Specific gravity (1 mark)
- v) Density (1 mark)

1.3 If heat is supplied to a 5kg mass of oil of specific heat capacity 1.6KJ/kgK at the rate of 4KW , calculate the time taken to raise the temperature of the oil from 15°C to 50°C . (5 marks)

1.4 A drop hammer is lifted to a height of 5m above the ground and then allowed to fall from rest on to a forging at ground level. Calculate the downward velocity of the hammer when it strikes the forging. (5 marks)

- 1.5 i) Calculate the work done in lifting a mass of 800kg through a height of 40m . (3 marks)
- ii) If the work done in moving a body is 1.5KJ and the time taken to do the work is 12 seconds, find the power used. (2 marks)

29

50
329
3
2

- 1.6 A stud has a diameter of 14mm at the bottom of the thread. If the maximum tensile stress allowed in the material is 30MPa , calculate the safe load the stud can carry. (5 marks)
- 1.7 A copper ingot in the form of a sphere has a diameter of 60mm . Calculate the increase in volume of the sphere if the temperature is increased from 80°C to 320°C . The coefficient of linear expansion of copper is $30 \times 10^{-6}/\text{K}$. (5 marks)
- 1.8 a) State two factors which affect the value of the coefficient of friction. (2 marks)
- b) State any three (3) methods to reduce friction in engineering. (3 marks)

SECTION B

QUESTION 2

- a) Define the term 'moment'. (2 marks)
- b) A beam AB, 5m long is simply supported at its ends in a horizontal position. Its mass is equivalent to a force of 400N . Point loads of 12kN and 20kN act on the beam 1.2m and 2.5m from point A respectively.
- i) Determine the reactions of the supports. (9 marks)
- ii) Determine the position to which the 12kN load must be moved for the reactions at supports to be equal. (4 marks)

QUESTION 3

A casting with a mass of 10kg rests on a sloping surface making an angle of 13° with the horizontal. The coefficient of friction is 0.5 . Calculate the force parallel to the slope, which has to be applied to move the casting:

- a) Upwards against the slope. (8 marks)
- b) Downwards against the slope. (7 marks)

QUESTION 4

An effort is applied at a radius of 250mm on a screw jack of pitch 2mm . An effort of 10N lifts a load of 6kN . Calculate:

- a) Velocity ratio (3 marks)
- b) Mechanical advantage (3 marks)

- c) Work done on load when the load is lifted 48mm . (3 marks)
- d) Work done by effort in lifting load 48mm . (3 marks)
- e) Efficiency (3 marks)

QUESTION 5

- 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/Kg K . Specific latent heat of fusion of the alloy = 210kJ/kg . (7 marks)
- b) A copper tank is filled with 1200 litres of petrol at 8°C . What volume of petrol would overflow when the temperature rises to 13°C ? Coefficient of linear expansion of copper = $17 \times 10^{-6}/\text{K}$. Coefficient of cubical expansion of petrol = $125 \times 10^{-5}/\text{K}$. (8 marks)

QUESTION 6

- a) A bus leaves a bus stop and accelerated uniformly for 10 seconds over a distance of 100m . It then moves uniformly with the speed it has attained for 30 seconds and finally retarded uniformly to rest at the next stop. If the two bus stops are 1km apart, calculate:
- i) Maximum velocity (3 marks)
 - ii) Acceleration (2 marks)
 - iii) Total time taken (3 marks)
- b) The armature of an electric motor is running at 100 revs/sec . When the current is switched off the armature comes to rest in 12 seconds. Calculate:
- i) The angular retardation (average) (3 marks)
 - ii) The number of revolutions made by the armature in coming to rest. (4 marks)

QUESTION 7

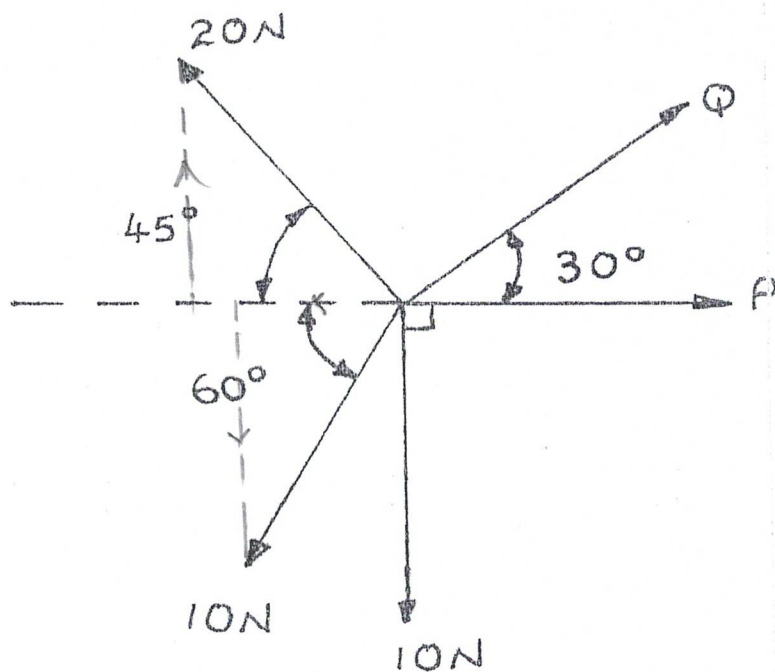


Fig. Q7.

The system is in equilibrium under the action of five coplanar forces as shown on the diagram Fig. Q7 above. Determine analytically the magnitudes of the two forces P and Q shown. (15 marks)

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