THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

035

ENGINEERING SCIENCE
(For Both School and Private Candidates)

Time: 3 Hours ***Monday, 10th October 2011 a.m.***

Instructions

1. This paper consists of sections A, B and C.
2. Answer **all** the questions in sections A and B and **three (3)** questions from section C.
3. Calculators are **not** allowed in the examination room.
4. Cellular phones are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).
6. Where necessary use:
   - Acceleration due to gravity, $g = 10m/s^2$
   - Density of water = $1000kg/m^3$

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SECTION A (10 Marks)

Answer **all** questions in this section.

1. For each of the items (i) – (x), choose the correct answer from among the given alternatives and write its letter beside the item number.

(i) Which of the following three physical quantities are scalars?
A Force, mass and energy
B Weight, distance and power
C Speed, mass and distance
D Displacement, velocity and speed
E Mass, velocity and acceleration.

(ii) The instrument used to detect the presence of an electric charge is called
A Voltmeter B Ammeter C Galvanometer D Voltammeter
E Ohmmeter.

(iii) The density of most liquids decreases with increasing temperatures because their volumes
A increase while their masses decrease
B increase more than their masses
C decrease while their masses remain constant
D increase with increase in masses
E increase while their masses remain constant.

(iv) The mass of a piece of cork ($0.25 g/cm^3$) is 20g. What fraction of the cork is immersed when it floats in water?
A 80 B 20 C 25 D 0.25 E 2.5.

(v) A bus carrying a very big load on its top carrier can easily overturn because its centre of gravity is
A on the carrier of the bus B outside of the bus C at higher part on the bus
D at the centre of the bus E at lower part on the bus.

(vi) If the heating element of an electric kettle is labelled 3 kW 240 V, what is the resistance of the element?
A 20.5Ω B 19.2Ω C 0.205Ω D 0.0192Ω E 1.92Ω.

(vii) What are the three main effects of an electric current?
A Heating, Magnetic and Chemical
B Mechanical, Electrical and Magnetic
C Heating, Kinetic and Chemical
D Chemical, Heating and Mechanical
E Kinetic, Chemical and Heating.

(viii) Which of the following allows some light to pass through it but we cannot see through it?
A transparent B opaque C translucent D nylon E reflection.

(ix) Which of the following are wave parameters?
A crest, diaphragm and amplitude
B antinodes, wind and trough
C crest, antinodes and trough
D diaphragm, trough and amplitude
E crest, wind and trough.

(x) The wavelength of sound waves moving at a velocity of 34 m/s and a frequency of 1000 Hz is
A 0.034m B 34m C 3.4m D 0.0034m E 0.34m.

SECTION B (30 Marks)

Answer **all** questions in this section.

2. Both metals A and B loose the same quantity of heat when their temperatures fall from 50° C to 10° C. The specific heat capacity of A is twice that of B. Find the mass ratio of B to A.

3. (a) State Faraday's first law of electrolysis.

(b) How long will it take to liberate 1.55g of silver by electrolysis using a current of 0.45A? (e.c.e. of silver = 0.001118g/c).

4. Mention three fundamental physical quantities and identify the instruments used to measure each one.

5. Briefly explain the three classes of lever.

6. With the aid of sketch, describe briefly three types of equilibrium of forces.

7. (a) Mention two conditions for an object to be in equilibrium when subjected to a number of parallel forces.

(b) If a 150g weight is used to balance the 80g and 20g weights on a beam, determine the distance x as shown in Figure 1.



Figure 1

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8. By using appropriate graph, determine the position, size and nature of the image of an object 20mm tall, standing on the principal axis of a concave mirror of focal length 60mm and 102mm from the mirror.

9. A piece of wood of density $0.9g/cm^3$ and volume $30cm^3$ floats in a liquid of density $1.2g/cm^3$. Find the following:
   (a) Mass of liquid displaced.
   (b) Volume of wood under the liquid.

10. (a) Define the SI unit of force.
    (b) A helical spring is shortened by 25mm when a compressive load of 150N is applied. Calculate the total length shortened if an additional of 90N were applied.

11. With the aid of sketches describe briefly the behaviour of magnetic bar between:
    (a) two like magnetic poles that are close to each other.
    (b) two unlike magnetic poles that are close to each other.

SECTION C (60 Marks)

Answer **three (3)** questions from this section.

12. (a) (i) State the principle of the conservation of energy.
    (ii) Define the SI unit of Work. **(2 marks)**
    (iii) A stone of mass 2kg is released from a height of 2m above the ground. Find the kinetic energy of the stone when it is at a height of 0.5m above the ground. **(4.5 marks)**

    (b) A small iron ball is dropped from the top of a vertical cliff and takes 2.5seconds to reach the sandy beach below. Find:
    (i) The velocity with which it strikes the sand.
    (ii) The height of the cliff.
    (iii) If the ball penetrates the sand to a depth of 12.5cm, calculate its average retardation. **(7 marks)**

    (c) A stone is thrown vertically upwards with an initial velocity of 30m/s from the top of a tower 20m high. Find
    (i) the time taken to reach the maximum height.
    (ii) the total time which elapses before it reaches the ground. **(6.5 marks)**

13. (a) Define the following terms as applied in an electrical circuit:
    (i) Shunt.
    (ii) Multiplier. **(2 marks)**

    (b) An ammeter gives its full-scale reading for a current of 0.4A and its resistance is 1Ω. With the aid of sketch, show by calculations how you would adapt it in the following scenarios:
    (i) to give a full-scale of 3.0A.
    (ii) for use as a voltmeter to read up to 200V. **(8.5 marks)**

(c) Figure 2 shows an electric current circuit, with the aid of sketch, calculate the current flowing through each resistance in the circuit. **(9.5 marks)**

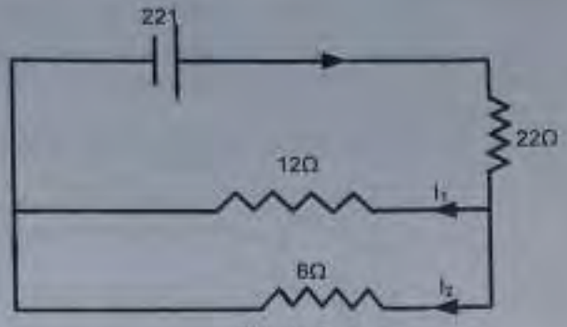


Figure 2

14. (a) A loaded wheelbarrow of weight 1120N is pushed up an inclined plane by a force of 160N parallel to the plane (Figure 3). If the plane rises by 100cm for every 800cm distance measured along the plane, find the velocity ratio, mechanical advantage and efficiency of the plane. **(6 marks)**

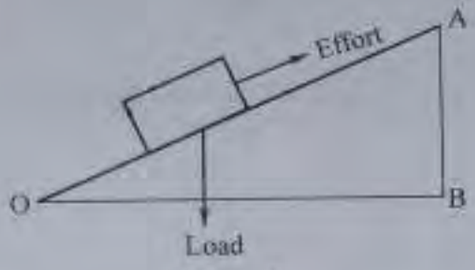


Figure 3

(b) The handle of the screw-jack is 45cm long and the pitch of the screw is 0.6cm. What must be applied to the end of the handle when lifting a load of 2500N if the efficiency of the jack is 50%? **(8 marks)**

(c) The hydraulic press consists of a cylinder and piston of large diameter connected by a pipe to a force pump of much smaller diameter as shown in Figure 4. Calculate the pressure produced by force pump and the upthrust to the piston in the large cylinder. **(6 marks)**

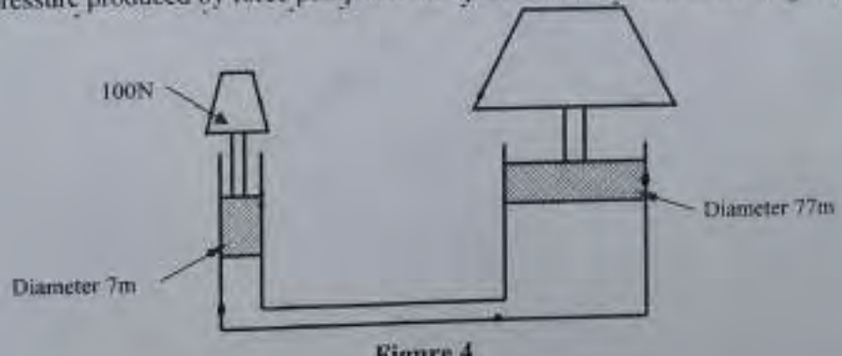


Figure 4

15. (a) Define the following:
(i) Static friction.
(ii) Kinetic friction. **(2 marks)**

(b) Figure 5 shows a block of metal 3 tonnes at an inclined plane at 30° being pulled by a force of 20kN. By the aid of sketch, calculate:
(i) The normal reaction to a block.
(ii) The coefficient of friction between block and surface of plane. **(12 marks)**

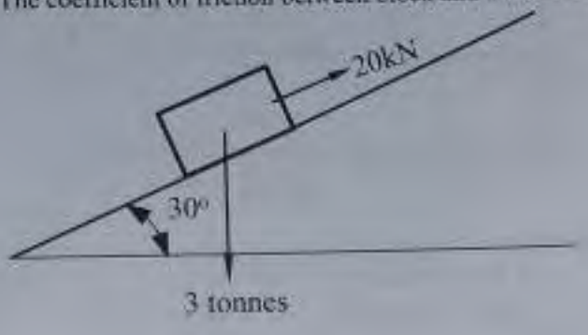


Figure 5

(c) (i) Define force.
(ii) By using analytical method calculate the resultant force from the number of forces acting at a point O in Figure 6. **(6 marks)**

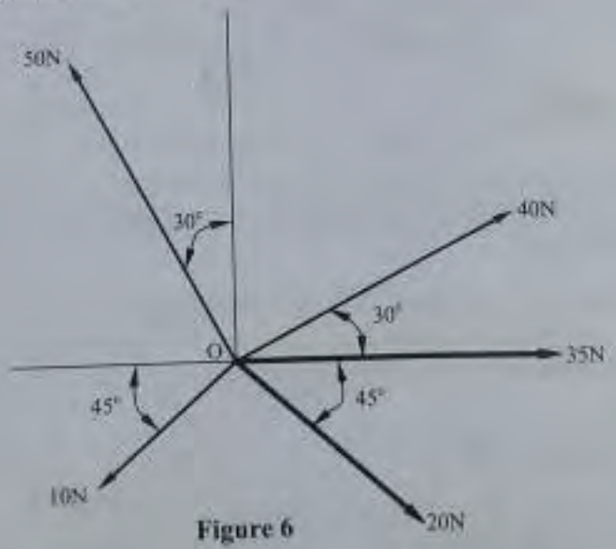


Figure 6

16. (a) Define the following:
(i) Heat capacity.
(ii) Specific heat capacity of a substance.
(iii) Specific latent heat of vaporization.
(iv) Specific latent heat of fusion.
(v) Latent heat of a substance. **(5 marks)**

(b) A bath contains 100kg of water at 60°C. Hot and cold taps are then turned on to deliver 20kg per minute each at temperatures of 70°C and 10°C respectively. How long will it be before the temperature in the bath has dropped to 45°C? Assume complete mixing of the water and ignore heat losses. **(10.5 marks)**

(c) A piece of copper of mass 40g at 200°C is placed in a copper calorimeter of mass 60g containing 50g of water at 10°C. Ignoring heat losses, what will be the final steady temperature after stirring?
Given that:
- specific heat capacity of copper = 400J/kgK.
- specific heat capacity of water = 4200J/kgK. **(4.5 marks)**