INSTRUCTIONS

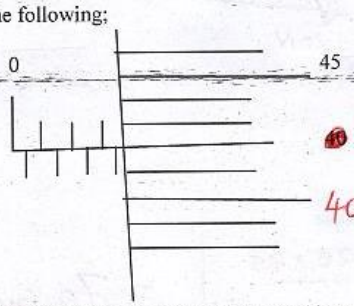
1. Write your name, index no, signature and date in the spaces provided above.
2. The paper consists of two sections, Section A and B.
3. Answer **ALL** the questions in section A and B in the spaces provided.
4. **ALL** answers and working **MUST** be clearly shown.
5. Mathematical tables and electronic calculators **may be** used.

SECTION A (25 MARKS)

Answer ALL the questions in this section in the spaces provided.

1. Thermodynamics is one of the branches of physics. What does it entail? (1mk)

2.(a) What is the reading in the following; (1mk)



3.5 + (42 × 0.01)
3.5 + 0.42
3.92mm

(b) If the reading above was the diameter of a spherical ball; find its volume. (2mks)

Volume $= \frac{4}{3}\pi r^3 \Big| = \frac{4}{3}\pi \times \left(\frac{3.92}{2}\right)^3 = 31.54\ mm^3$

3. State two factors which affect the spring constant. (2mks)

- Diameter of the spring
- Thickness of the material
- Type of material

4. State the relationship between mass and weight. (1mk)

$W = M \times g$

5.(a) State how the pressure in a moving fluid varies with speed of the fluid. (1 mks)

Increase in speed lowers the pressure of the fluid.

(b)Water flows along a horizontal pipe of cross sectional area 60 cm^2 which has a constriction of cross sectional area 24 cm^2 at one place. If the speed of water at the constriction is 5 m/s, calculate the speed in the wider section. (2 mks)

$A_1v_1 = A_2v_2$

$60 \times v_1 = 24 \times 5$

$v_1 = \frac{24 \times 5}{60}$

$= 2 m/s$

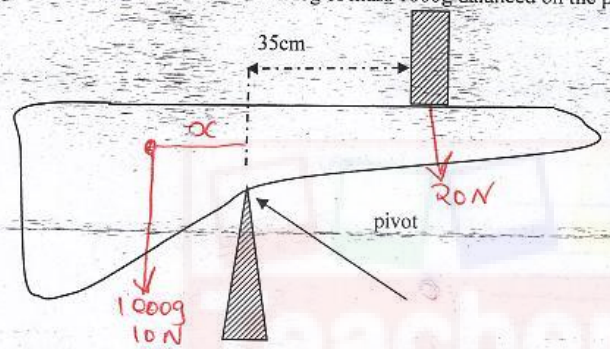
6.Explain why brakes fail in a hydraulic braking system when air gets into the system. (2mks)

Air is compressible

7.(i) State the principle of moments (1mk)

It states that the sum of clockwise moments about a point is equal to the sum of anticlockwise moments.

(ii)The figure below shows a non-uniform log of mass 1000g balanced on the pivot by a 20N weight as shown.



Determine the position of the centre of gravity from the pivot (2mks).

Clockwise = Anticlockwise

$20 \times 35 = 10 \times x$

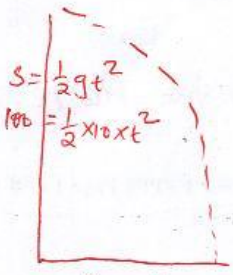
$x = \frac{20 \times 35}{10}$

$= 70$ cm from the pivot.

8.It is observed that a drop of milk carefully put into a cup of water turns the water white after sometime. Explain this observation (1mk)

Diffusion.

9.A bullet hits a stationary block at the edge of a cliff 100m high and moves with a common velocity of 200 m/s. Determine the maximum horizontal distance covered. (take g=10 m/s^2) (3 marks)



$100 = \frac{1}{2} \times 10 \times t^2$

$t^2 = \sqrt{20}$

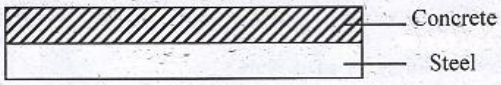
$t = 4.472$

$R = ut$

$= 200 \times 4.472$

$= 894.4 m$

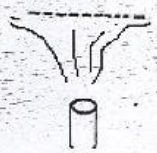
10. The figure below shows a beam balance made out of concrete and reinforced with steel



Use a diagram to explain the behaviour of the shape of the beam when heated up (2mks)

It remains with the same shape. Expansion of concrete and steel is the same.

11. When a Bunsen burner is lit below a wire gauze, it is observed that the flame initially burns below the gauze shown in figure (i). After sometime, the flame burns below as well as above the gauze as shown in figure (ii).



(i)

(ii)

State the reason for this observation. (1 mk)

12. a) State Newton's 2nd Law of Motion (1mk)

It states that the rate of change of linear momentum is directly proportional to the resultant force and it takes place in the direction of the force.

b) A car of mass 1200kg moving at 90km/h is brought to rest over a distance of 20m. Calculate the braking force (2 mks)

$F = ma$

$a = \frac{v-u}{t}$

also: $v^2 = u^2 + 2as$

$0 = 25^2 + 2 \times a \times 20$

$0 = 625 + 40a$

$\frac{-625}{40} = \frac{40a}{40}$

$a = -15.625$

$F = ma$

$= 1200 \times -15.625$

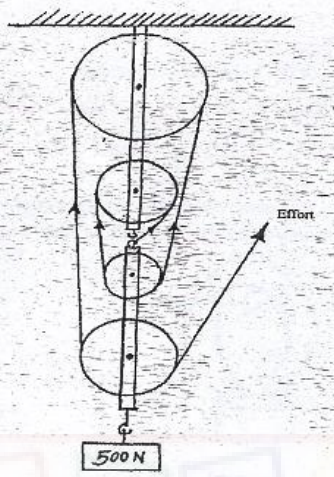
$F = -18750\,N$

SECTION II(55mks)
Attempt ALL the questions in this section in the spaces provided.

13. (a) Define the term velocity ratio as used in machines (1mk)

This is the ratio of the Effort distance to Load distance.

(b) Figure below shows a block and tackle pulley system lifting a load of 500N



(i) Determine the velocity ration of the machine (1mk)

5

(ii)If an effort of 120N is required to lift the load using the machines determine the efficiency of the pulley system (3mks)

$M.A = \frac{L}{E} = \frac{500}{120}$

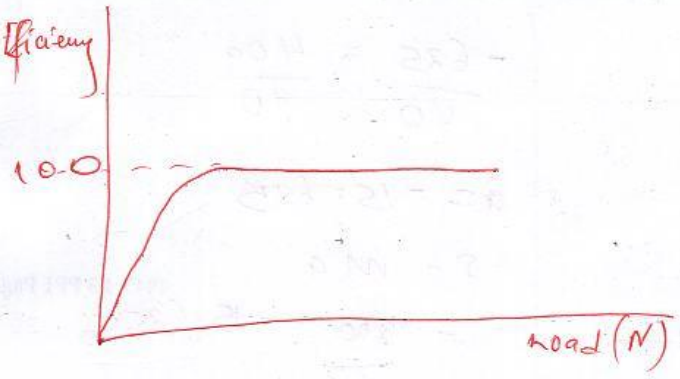
$= 4.1667$

$\eta = \frac{M.A}{V.R} \times 100$

$= \frac{4.1667}{5} \times 100$

$= 83.33\%$

(iii) In the space provided below, sketch a graph of efficiency against load for the system. (2mks)



14. A car of mass 2000kg travelling at 5m/s collides with a minibus of mass 5000kg travelling in the opposite direction at 7m/s, the vehicles stick and move together after collision. If the collision lasts 0.1 seconds

(a) Determine the velocity of the system after collision to 3 decimal places (3mks)

$m_1u_1 = (m_1 + m_2)v$

$(2000 \times 5) + (5000 \times -7) = (2000 + 5000)v$

$10\,000 + -35000 = 7000v$

$-25000 = 7000v$

$v = \frac{-25\,000}{7000}$

$= 3.571 \text{ m/s}$

(b) Calculate the impulsive force on the minibus (3mks)

$F = ma$

$a = \frac{v-u}{t}$

$= \frac{3.571 - 7}{0.1}$

$a = 34.29$

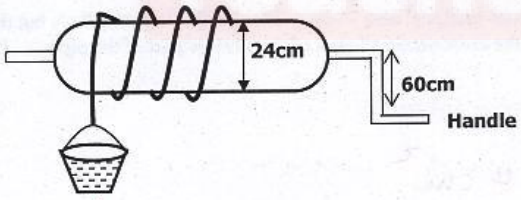
$F = ma$

$= 5000 \times 34.29$

$= 171,428.57 \text{ N}$

(c) Calculate the change in kinetic energy of the system to 5 significant figures (3mks)

15. The figure below shows a windlass. An effort is applied on the handle which is turned on a radius of **60 cm**. As the handle turns, a rope is wound around the drum of diameter **24 cm**, thus raising a bucket of water out of the well



a) If an effort of **20N** is needed to lift a bucket full of water of mass **8kg**, Calculate:

(i) The energy gained by the mass when the drum turns through one revolution (3mks)

In one revolution,

$\pi D = \pi \times 24$

Distance $= 75.398$ cm

Energy $= mgh$

$= \frac{8 \times 10 \times 75.398}{100}$

$= 60.32$ Joules

(ii) The work done by the effort during this revolution. (3mks)

In one revolution

$\pi D = \pi \times 120$

Distance = 376.99 cm

$E = F \times d$

$= 20 \times \frac{376.99}{100}$

75.39 Joules

b) Suggest a reason why the two quantities in a(i) and (ii) are not equal (1mk)

Friction

= Some of the energy is used to lift the movable parts.

c) Calculate:

(i) The velocity ratio of the machine (2mks)

$V.R = \frac{R}{r} = \frac{120}{24} = 5$

(ii) The efficiency of the windlass (2mks)

$M.A = \frac{L}{E} = \frac{80}{20} = 4$

$\eta = \frac{M.A}{V.R} \times 100$

$\frac{4}{5} \times \frac{80}{100}$

$= 80\%$

16. a) Differentiate Between streamline flow and turbulent flow (2 mks)

b) Water flows along a horizontal pipe of uniform cross-sectional area $30cm^2$. The speed of water is 8m/s but this increases to 10m/s in a constriction in the Pipe. What is the cross-sectional area of this narrow part of the pipe. (3 mks)

$A_1V_1 = A_2V_2$

$30 \times 8 = A_2 \times 10$

$A_2 = \frac{30 \times 8}{10}$

$= 24\ cm^2$

c) A liquid flows through a pipe with a velocity of 4.5 m/s on the wider side and 1.8 m/s on the narrow side. Determine the radius of the wider part if the narrow side has a diameter of 4cm. (3 mks)

$A_1V_1 = A_2V_2$

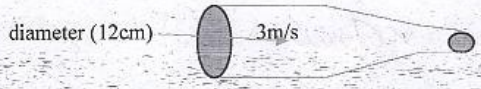
$\pi r^2 \times 4.5 = \pi \times 2^2 \times 1.8$

$r^2 = \frac{4 \times 1.8}{4.5} = \frac{7.2}{4.5}$

$r^2 = 1.6$

$r = 1.265\ cm$

d) In the figure below show the liquid that is in streamline motion. Calculate the speed of water in the narrow part of the tube if the speed of water in the larger pipe is 3m/s. The narrow sides diameter is 3cm (3 marks)



$A_1V_1 = A_2V_2$

$\pi \times 6^2 \times 3 = \pi \times 1.5^2 \times V_2$

$\frac{36 \times 3}{2.25} = \frac{2.25 V_2}{2.25}$

$= 48 \text{ m/s}$

17. A rectangular alluminium solid block of density 2700kg/m3 has dimensions of 40cm x 12cm x 6cm. the block rests on a horizontal flat surface. Calculate

a) Its weight (3 marks)

$M = V \times \rho$

$M = 40 \times 12 \times 6 \times 2.7$

$M = 7776 \text{ g}$

$W = \frac{77.76}{100}$

$= 77.76 \text{ N}$

b) The minimum pressure it exerts (2 mks)

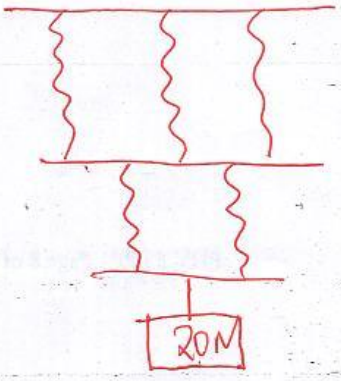
$\text{Pressure}_{min} = \frac{77.76 \times 10\,000}{40 \times 12}$ | $\frac{777600}{480}$ | $= 1620 \text{ N/m}^2$

c) The maximum pressure it can exert (2 mrk)

$\text{Pressure}_{max} = \frac{77.76 \times 10000}{12 \times 6}$ | $\frac{777600}{72}$ |

18. a)State Hooke's law (1 mk)

b)Determine the total extension below given the spring constant of the spring in 50 n/m. The springs are identical and has a mass of 10g and the supporting bar is of mass 20g. (3mks)



19. a) Define the term Density (1 mrk)

This is mass per unit volume.

b) An empty density bottle of mass 12g weighs 70g when full of water and 100g when full of liquid X. Given that the density of water is 1000kg/m3, determine the density of liquid X (3 mks)

Mass of water = 70 − 12
= 58g

Volume of water = $\frac{58}{1}$ = 58 cm^3

Mass of Liquid = 88

$\rho_{Liquid\ x} = \frac{88}{58} = 1.517\ g/cm^3$

c) A wooden block of mass 200g is 4.0cm long, 3.0cm thick and 6.0cm in width. Determine its density in kg/m3 (2 mrks)

$\rho = \frac{M}{V} = \frac{200}{4 \times 3 \times 6} = \frac{200}{72} = 2.778\ g/cm^3$