

CTEC LEVEL 3 IN ENGINEERING

Scenario

Premium Kettle Design 'OCR Small Appliances' design and manufacture a range of low cost / basic kettles typically sold in supermarkets. In order to stay competitive the managing director of 'OCR Small Appliances' has decided that they should move into the premium range kettle market. They need to design and manufacture a new electric kettle for this market and have already undertaken some preliminary research into the typical features found for this type of kettle, such as:

- lightweight rust and corrosion resistant
- integral pouring spout
- ergonomic handle
- cordless with a safe electrical connection
- hinged lid with spring-loaded release mechanism
- concealed heating element
- ON indicator light
- automatic thermostatic turn off
- water level gauge.



You have been asked to generate design ideas for a new premium electric kettle and develop one or more features using formal engineering techniques. You must present your design ideas and how you have optimised the design to the managing director at OCR Small Appliances. This could be done using a log of the design process that includes a portfolio of imagery that evidences the design and optimisation process. The log could be presented as an electronic or paper-based report showing your recommendations and thought processes and which demonstrates evidence of sketching, accurate engineering drawing.

You must clearly show the process of how you investigated existing kettle designs, and how you used sketching and engineering drawings to develop new designs. You could use a log of the design process to present as evidence. This log could include:

- a developed portfolio of sketches
- a developed, accurate formal engineering drawing
- a written technical justification of the design process using the principles of DFMA.

Answer **all** questions in the spaces provided.

1 (a) An electric heating element has a resistance of 60 ohms and is to operate on a 240 volt supply for two hours.

(i) Calculate the current taken by the heater.

.....
..... [2]

(ii) Calculate the power used.

.....
..... [2]



(iii) Calculate the energy used.

.....
..... [2]

(b) A battery has six cells connected in series. Each cell has an electromotive force (e.m.f.) of 1.2 volts and an internal resistance of 0.2 ohms.

Calculate the maximum power that this battery can transfer to an external load.

6 (a) Complete the table by naming each component from its graphical symbol shown.

Graphical Symbol	Component
	
	

[2]

(b) For a two-input NOR gate, complete the truth table showing the outputs.

Input A	Input B	Output OR gate	Output NOR gate

[2]

(c) (i) Explain the meaning of the term 'bistable multivibrator'.

.....

..... [1]

(ii) In the space provided, draw the symbol for a D-type bistable complete with labels D, Q, CK and \bar{Q} .

(iii) State the meaning of the labels, D, Q, CK and \bar{Q} for the D-type bistable.

D

Q

CK

\bar{Q} **[4]**

2 (a) Gear systems and belt and pulley systems are alternative methods of transmitting rotary motion. Give **one** advantage of each method:

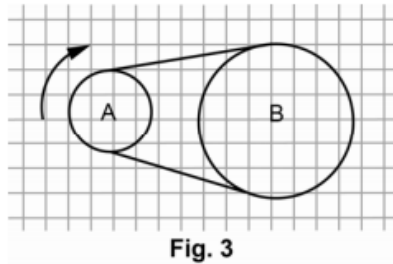
(i) One advantage of a belt and pulley system is:

..... [1]

(ii) One advantage of a gear system is:

..... [1]

Fig. 3 shows a simple pulley system.



The driving pulley (A) has a diameter of 75mm and the driven pulley (B) has a diameter of 200mm.

(b) Calculate the mechanical advantage of the system

..... [1]

(c) Give **one** reason why idler gears are often included as part of a gear system.

.....

(d) Fig. 4 shows a common type of gear system.

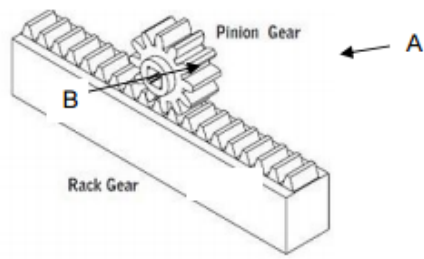


Fig. 4

(i) Name component A [1]

(ii) Name component B [1]

(iii) Give one application for this type of gear system.

.....
..... [1]

4 Fig. 7 shows a tower crane.

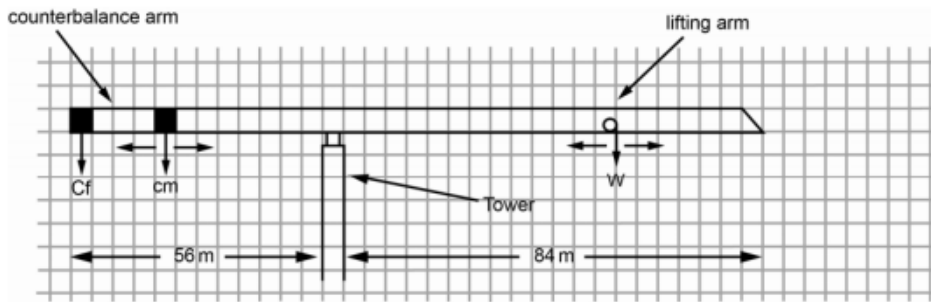


Fig. 7

The counterbalance arm is carrying a fixed counterbalance weight (C_f) and a mobile counterbalance weight (cm). Each weight has a mass of 2 tonnes.

The counterbalance arm has a length of 56m, and the length of the lifting arm is 84m. The total mass of the arms is 10 tonnes. The construction of the arms is uniform.

The weight (W) lifted by the crane can move along the arm to any position from the tower supporting the arms. The movable counterbalance is used to eliminate any turning moment at the connection with the tower.

- (a) (i) Calculate the distance from the tower that the movable counterbalance should be placed when the crane is unloaded.

.....
..... [2]

- (ii) Determine the maximum load that can be lifted by the crane at the furthest point from the tower.

..... [1]