

Engineering and construction: helmets

[Engineering](#)



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TMA T173 03

Question 1

a. Explain why standards are important to manufacturers and users of helmets. (4 marks)

Helmets are part of PPE (Personal Protective Equipment) in any instance where overhead weights and objects are involved (Hillert, 2007, p. 301).

Standards in the manufacture of the helmet are important for they take into consideration a number of factors, agreed upon by the professionals using the PPE. Standardization offers a means by which the manufacturer can fabricate a product suited for different and specific uses by analysis of various physical, chemical, biological and human based parameters of using the product, such as strength of the helmet in a construction site.

b. i. In your own words, give a brief description of what the standard covers. Standard is a measure of assurance to any specific area of application. It covers a number of elements such as uniformity, specialization, purpose, precision and accuracy. Uniformity of standard is a frame of reference that the users of a given object can agree to follow regarding the manufacturing and usage of that particular design as well as the object material (Callister, 2004, p. 503). Uniformity regards the conformity of products regarding their physical and chemical nature. Specialization involves the product being designed for a specific project such that outside the same parameters, it's an inadequate design. Purpose in standardization is the objective that is associated with a given outcome. Purpose may be safety, protection, repairs, constructions and more. Precision and accuracy in standardization are concerns of the physical fitting associated with an outcome. The simplest <https://assignbuster.com/engineering-and-construction-helmets/>

measure of accuracy and standardization lies in the sizes of the products.

Size determines the fitting of the object.

ii. Give a brief description, from the sections of the standard, of five basic design requirements for the helmet.

Uniformity: the design of the helmet has to be specific to the initial design solution, for a particular product such that all the helmets of a design are similar and as close as possible to the suggested solution.

Specialization: helmets in use are designed for various purposes, the cycling and the industrial helmets are quite different and they are specific to their function. In this case specialization means that the design of the helmet meets the needs of a given industry as noted above.

Purpose: the helmet is basically a protective equipment, but different scenarios have different dangers and risk. The purpose of the helmet is to protect the head from injuries, but it is specific to the type of injuries.

Precision: precision of the helmet involves the testing capacities. The device is supposed to withhold a given force of a certain nature. In considering the forces involved, the helmet is designed for a certain force under which it serves its purpose.

Accuracy: accuracy of the helmet provides a range in which the helmet maintains and performs its functionalities (Volland, 2003, p. 298). Accuracy falls within the testing range as well, but provides an average under which the helmet is to serve its purpose.

c. BS EN 1078 specifies the following for the testing of the helmet:

- a dummy head of mass 6.1 kg in a test helmet is dropped onto a stationary anvil
- two impact speeds are used of 5.42ms⁻¹ and 4.7ms⁻¹

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- the test requires that the deceleration experienced by the dummy head does not exceed $250 \times g$ where g is the acceleration due to gravity.

i. Show that the heights from which the helmet and dummy head should be dropped in the tests are equivalent to those stated in the note to section 4. 4 of the standard. Show your working, and state any assumptions that you make.

Assumption: the dummy freefalls from the initial position, where $V_0 = 0 \text{ ms}^{-1}$

$V^2 = 2 aS$, where a is the acceleration due to gravity g which is approximated at 9.8 ms^{-2}

i. $(5.42)^2 = 2(9.8)S$

$$S = 29.3764 / (19.6) = 1.498795918 \text{ m} = 1.5 \text{ m}$$

ii. $(4.7)^2 = 2(9.8)S$

$$S = 22.09 / (19.6) = 1.127040816 \text{ m} = 1.1 \text{ m}$$

ii. Estimate the maximum force experienced by the head during an acceptable impact.

During impact the maximum allowable force for the dummy is based on the maximum allowed deceleration ($250g$).

From $F = ma$, then the maximum allowable force on the dummy is:

$$6.1 \text{ Kg}(250g) = 1525g \text{ where } g = 9.8 \text{ N/Kg}$$

$$= 14945 \text{ N}$$

iii. Explain any similarities between the helmet and a car airbag in providing safe deceleration.

The design of the helmet and the airbag differs in how they work as well as the material used for their purposes. The helmet is designed to provide safety by resisting the force of impact via tensile strength whereas the

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airbag is designed to minimize the impact by reducing the impact via absorption of the momentum of the body upon impact.

Question 2

The resource for this question is Patent Specification 1 448 945 for a lawnmower improvement, and was filed by Husqvarna in 1974. This lawnmower is shown as part of the product design evolution in Figure 2. 46 of Block 3 Part 2.

You will not be asked to unpick the complex technical language in the patent, but you should be able to extract key points using the guidance given.

Read the entire patent document and then answer the following questions.

The questions will point you towards the key areas you need to answer.

When answering the questions, try to interpret the information in the patent in your own words. Do not supply long quotations from the patent document without explanation or you will be penalised.

a. What are the main features of an invention that must be present in order for it to be patentable?

In the design of the lawn mower, the blades and the motor in the design are the functional elements. However presentation is determined by the casing of the device. The features that determine presentation of the lawn mower revolve around handling and housing the operant bits: casing, handlebars, collection bag, wheels and operating controls.

b. Describe, in your own words, the function of the improvement that is specified in the invention. What problems with existing lawnmowers does the improvement seek to solve? To answer this question, you should concentrate on the information given on the first page of the patent. You should be able

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to provide a good answer in no more than 10 sentences.

Improvement in the case of the lawn mower is defined by the ability of the device to provide a defined and smooth cut. The current problem that the improvement seeks to address happens to be the unevenness of flatness provided by the blades which should be in the form of a dish. The mower is designed such that the height of the cutting edge can be acquired by adjusting the height of the rotary wheels, which guide the mower regarding the cutting. Although the blades of the mower may take on a flat or level appearance, the cut is not smooth, especially when dealing with large growths and adjusting the mower's height independently allows an angulated cut which smoothens the cut since the blade is used in cutting through the grass at two levels (a higher level at the front and lower at the rear). The improvement may also be defined as giving the user the ability to choose the height of mowing for both ease and smoothness (Callister, 2006, p. 282).

c. What material of construction is suggested for the body of the lawnmower? Explain briefly why the material of construction is not suggested as one of the claims of the patent.

The materials that were suggested in constructing the body of the lawnmower are thermoplastics. The material of construction is not suggested in the patents for:

- i) it is not an invention done by the construction company,
- ii) the material had been used in other designs of the lawn mower and other household equipment,
- iii) the material chosen for the design was subject to change in the future with improvements to the design and that would mean changing the patents

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with every new choice of material, and

iv) the material field is wide such that no claim would have sufficient engineering grounds.

Question 3

Figure 5. 20b of Block 3 Part 5 shows the phase diagram for the aluminium-silicon alloy system.

1. When heated, at what temperature would an alloy with composition 80% aluminium with 20% silicon (this composition has been marked by the red dashing line).

i. begin to melt?

From the phase diagram, the melting point of the alloy composition 80% aluminium and 20% silicon is approximately 570°C

ii. become completely liquid with further heating?

The 80% aluminium 20% silicon alloy would completely turn into liquid at approximately 698°C.

1. Explain why an alloy composition of about 12% silicon (the eutectic composition) is used as a casting alloy for aluminium.

The reason behind using the eutectic composition of 12% silicon in aluminium is the resultant mechanical properties. The mechanical properties of the eutectic composition are usually better and resemble pure solids in operations. By the composition having a common melting point, the composition of the alloy can be easily defined and the operation conditions easily quoted (Khan and Raouf, 2005, p. 403). The microstructure of eutectics is characterised by a better binary and bonding outcome.

2. There is growing environmental pressure for the removal of lead from consumer products. Describe, in no more than about 400 words, the

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arguments for and against the removal of lead from these products. Your answer should cover the technical impact of any changes resulting from the removal of lead.

Lead as a subject in the technical applications has both supporters and opponents. There are arguments that it should be struck out of use due to the hazards it poses. Lead has been identified as a dangerous substance to the environment as well as the users. The material has been associated with a number of conditions such as cancer, which presses on the necessity of removing lead from consumer products. Lead is associated to several medical conditions, which can be interpreted, by consumers and the market as being a hazard that can be avoided. Lead affects the environment in many ways. Lead leaches into the ground and is often transferred from water to soil to animals (especially aquatic) which means that it finds its way into the human being via other channels, even when avoided in products. Due to this, the use of lead in various products is strongly opposed.

Lead, as a metal is necessary for various applications that are used by the consumers, such as solder. Its elimination in such industries would mean that there is no product produced as it is a necessity in the production process. Furthermore, there is no alternative substitute for the lead used in the production process (Callister, 2006, p. 82). According to use, any other product that could be used in place of lead happens to be its by-product, which does not solve the problem to start with. Though deemed harmful, there is very little evidence of the indirect hazards it poses. In addition, using lead does not institute a hazard, its use in huge quantities that poses the dangers associated with the product. Most industries associated with using lead use controlled quantities, which hardly poses any danger to the users.

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Khan, Wasim, A., and Abdul Raouf S. I. (2005) *Standards for Engineering Design and Manufacturing (Dekker Mechanical Engineering)*. CRC Press, New York.

Voland, Gerard. (2003) *Engineering by Design*. London, Prentice Hall.