

b)ii

1a) A major advantage of the Solid State Laser welding Process is that it has low thermal distortion compared to traditional methods. This makes it better for use on small, precise components. Laser welding can also be done manually by an operator or it can also be done by machine for repeatable jobs. This can eliminate vast amounts of preparation time. The workpieces that are to be welded must be held securely. During laser welding a molten pool of metal is produced. The gas being used is blown around the position of the weld to shield the molten metal. The main purpose of the shield gas is to prevent oxidation and plasma formation. Helium and Argon are the most commonly used gases as they have high ~~ionization~~ ^{ionization} potential. Surfaces must be cleaned before welding to ensure no foreign objects enter and contaminate the weld. The major downside to Solid State laser welding is that it is incredibly expensive ~~and~~ in the initial cost of purchasing the equipment. They are safer than other methods to use though as they don't produce x-rays and don't require a vacuum to operate.

1b)i) Tungsten Arc ^{gas} Shielding is also known as TIG (Tungsten Inert Gas) welding in industry. The most common gas for TIG welding is Argon. This is ~~used~~ because it's the most versatile and can be used for welding all grades of ^{Stainless Steel} ~~metals~~. Helium can be added to the Argon to form a mixture to increase the fluidity and penetration of the weld pool. ~~Argon~~ Hydrogen gives the same effect as helium but in much smaller concentrations so you don't have to use as much, but can't be used on ferrous metals. I think Argon is a good gas for this process as it's cheap and plentiful.

b)ii) TIG welding is a Versatile and extremely Strong Process of welding metals. However its not to Say that there arent Potential issues with defects or distortion. Porosity can occur when excess gas gets trapped inside the weld which can reduce the Strength of the join. Porosity is Visible to the naked eye which makes it easily detectable. To reduce this happening the operator must ensure there is an exit point for the gases to escape. Distortion can be caused by high energy density from the welding rod travelling too slowly over the base material. This leads to the metal distorting and compromising the quality of the weld. It can be avoided by ensuring a Steady travel speed across the weld and a reduction of the energy used. Another major defect that can happen is inclusions. Inclusions occur when slag isnt properly removed from the weld pool before the next pass is made. They cause weaknesses in the weld that can lead to failure. It can be avoided by upping the Amperage.

2a)i) The bonding of thermal spraying is thicker in thermal spraying than other methods such as electroplating. Electroplating uses magnetism so layers can be particles thick. Thermal spraying uses heat and force to attach the coating on and tends to be between ~~250~~ 250-500 microns. Adhesion is usually better due to the forces involved with the process, although the coating is more likely to crack compared to other methods.

ii) Thermal spray coating is porous and can overlap each other, this leads to its ability to crack. The only inclusions that can occur is whatever is in the air between the spray gun and the object to be coated. Whereas with processes such as weld cladding the slag in the weld pool could cause inclusions and oxidise the coating.

iii) Most coating processes use powders for the coating. Thermal spraying is one of the main ones for this type. Such exposure to fine powders can cause some severe health effects as skin irritation and asthma. To avoid harm, operators must have skin covered at all times including the head. Breathing apparatus is also essential to stop particles entering the lungs. Risk assessments of the operating area must be carried out regularly due to COSHH regulations and the nature of the materials used.

2b) Nickel alloys work extremely well at high temperatures, other metals start experiencing creep at these temperatures but not nickel alloys. Nickel has a low diffusivity which means the atoms in its lattice structure move less easily than other metals once excited by heat. As atoms in other metals begin to move and succumb to creep, nickel atoms hold strong. The structure of the grains in nickel is another reason it's good at resisting creep. Nickel has larger grains than other metals so there are less paths for creep to accelerate through it. Nickel alloys also order harden their atoms

3 into optimized order so that it makes dislocation of the boundaries a lot harder to achieve. This makes them more rigid.

3a) i) Recovering and recycling polymers is a difficult task thanks to the fact they aren't magnetic. This makes it difficult to ~~sort~~^{Sort} through from other various types of waste. Magnets can simply pick them up and place them in their relevant group. Another issue is the amount of sub categories polymers get sorted into such as PVC, PP, HDPE, LDPE and so on. They all can be recycled together due to their make-up and multiple properties which vary greatly. There is a machine that can sort them using a laser scanner but it's expensive and more time consuming compared to traditional methods of recycling. Metals can be hard to recycle due to their weight.

ii)

If the recycled material gets contaminated then it can have a big impact on the recyclability of it. For example plastic food containers that haven't been washed out properly going to recycling for melting back down would be rejected. This would be due to the risk of contamination from the food to the plastic. Proper recycling of metals is also important as it can have a big environmental impact as the metal has to be scrapped instead of remelted down. Contamination can lead to ^{recycled} materials becoming weaker or taking on other properties not meant for that particular material.

b) Name	Composition	Properties
Austenitic Stainless Steel	Contain Austenite which can absorb up to 2% Carbon, turns from BCC* to FCC* during heating to 912°C	Corrosion resistance Good Microbial Cleaning. Work harden in cold conditions
Ferritic Stainless Steel	made up of up to 0.025% iron. Low amount of Carbon absorbed due to BCC Structure.	Good heat and Corrosion resistance Magnetic up until the Curie Point Crack under heat zones.
Martensitic Stainless steel	From 0.1-1.2% Carbon, high in Chromium and has a BCC Structure.	Good mechanical properties ability to harden under heat Low formability

* BCC = Body Centred Cubic FCC = Face Centred Cubic

4a) The manufacturers ^{that} claim an improved environmental impact due to the aluminium alloys are only telling some truth. Yes, with the weight saved through using aluminium instead of other ^{materials} ~~conditions~~ it would reduce the weight of the car and thus the amount of fuel needed to power it the same distances. But what they ~~don't~~ say is that Aluminium takes a lot of energy to produce compared to other metals. Also by talking about the weight saved they ignore the durability steel offers compared to aluminium. If the steel body outlasts an aluminium one then it's more environmentally friendly as another aluminium body would have to be created and increases its carbon footprint. This would give it a worse carbon life cycle than the steel body.

Toyota	material	Range rover
$1175 \times 14.5 = 17037.5$	Steel	$1100 \times 1.2 = 1320$
$300 \times 1.2 = 360$	Aluminium	$800 \times 14.5 = 11600$
$50 \times 9 = 450$	Copper	$50 \times 9 = 450$
$120 \times 1.5 = 180$	Plastic	$120 \times 1.5 = 180$
18,027.5	Total	13550
(kg)	(kg/kg)	
$250,000 \times 0.24 = 60,000$ 60,625 kg	Emissions (CO ₂ /L)	$250,000 \times 0.24 = 60,000$ kg over Lifetime

As you can see the total emissions to build and run the Toyota are worse than the Range Rover even though the Range Rover is heavier.

c) Heat production - heat can be recycled to give a negative impact on Carbon Footprint.

Waste product - Research into ^{uses for} the waste product such as the coke could lower Carbon Footprint

Waste gases - Use waste gases for other uses and recycle them.

Proper maintenance - Proper maintenance of cars can lead to less repairs and LESS new components created. Reducing carbon footprint.