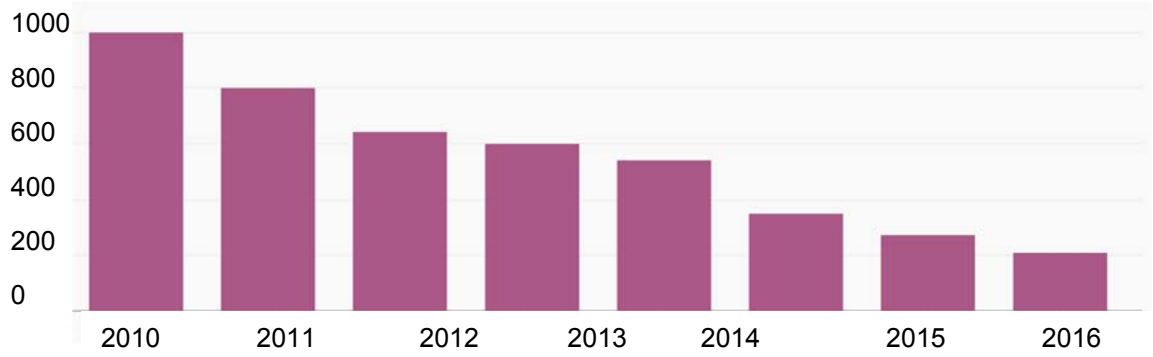
Answer **all** questions.

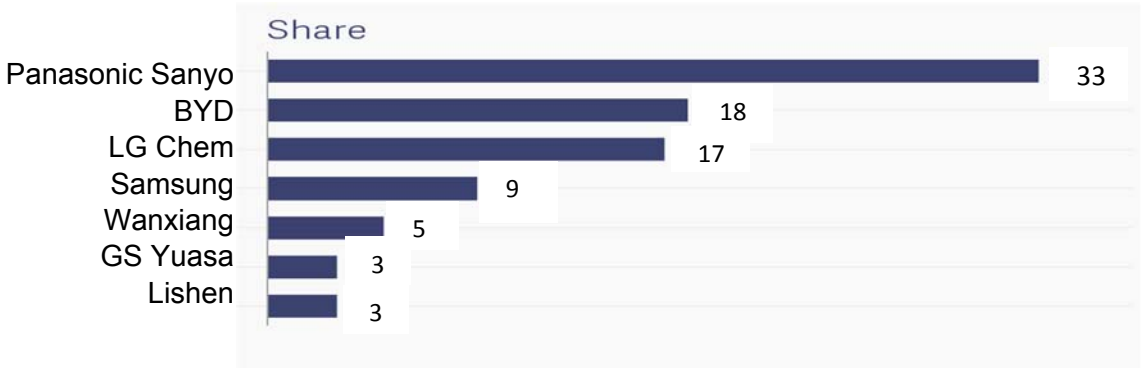
Question 1: The Rise of Electric Vehicles

Figure 1: Global price of lithium-ion battery (US$/kilowatt hour)



Source: *Bloomberg New Energy Finance*, accessed 5 July 2018

Figure 2: 2018 Lithium-ion battery global market share (%)



Source: *Statista*, accessed 5 July 2018

Extract 1: Technology is fuelling the use of cobalt

Cobalt is a hard, shiny and greyish metal which has many strategic and irreplaceable industrial uses as a result of its unique properties. Currently used in numerous industrial chemical processes, close to half of the world's cobalt supplied today is used in lithium-ion batteries, putting it at the heart of the drive for alternative and renewable energy systems. There has not been a good substitute to make lithium-ion batteries without the mineral.

In 2017, lithium-ion batteries used in portable consumer electronics took up around 72% of total cobalt used in lithium-ion batteries. Each new electric vehicle, which runs on lithium-ion battery, uses about 10 kg of cobalt.

In recent years, electric cars have knocked diesel off its perch as the fuel with the smallest carbon footprint. Diesel also releases greater quantities of nasty gases other than carbon, such as nitrogen oxides, than petrol does. Many cities in Europe and the rest of the world want to eliminate diesel cars from their roads as early as 2025. Governments hope that the void left by diesel will be filled by zero-emission battery-powered models. But mass adoption of such vehicles, which for now are expensive and have limited ranges, still appears a way off.

Sources: *https://www.dartoncommodities.co.uk/* (accessed on 21 July 2018) and *The Economist*, 13 February 2018

Extract 2: Charging ahead, China's dirty race for clean vehicles

After a decade of halting progress, electric cars are zooming ahead in China. Last year the number of registrations of new electric vehicles (EVs) in the country overtook that in America, making it the world's biggest and fastest growing market. The category includes electric-only cars as well as plug-in hybrids that can also run on petrol. Analysts expect the market to grow by nearly 50% a year for the rest of this decade.

The government has had a big role in the marked expansion of EVs in China. It doles out generous subsidies to local makers, to parts suppliers and to those who buy the final products. Last year alone, China shovelled over 90 billion yuan in subsidies into the industry, which it calls "strategic". This has led to queues of EVs on the streets, mostly of poor design and quality. China has yet to produce an EV manufacturer that can compete at the level of America's Tesla Motors.

The Chinese government is also encouraging other Chinese firms, including the country's tech giants, to innovate in the field. Tencent, a gaming and social media firm, is developing internet-connected EVs with Taiwan's Foxconn. Alibaba, an e-commerce firm, is providing data and cloud-computing services to Kandi Technologies, a local EV-maker that is popularising the sharing of the vehicles.

Source: *The Economist*, 28 July 2016

Extract 3: German cars have the most to lose from a changing auto industry

Carmaking is Germany's biggest industrial sector but cars are changing. Electric power and autonomous vehicles will alter radically the way they are used. The difficulty in adapting threatens not only future revenues and profits at the big three—Daimler, BMW and Volkswagen –but also Germany's status as a mean economic machine. However, the German carmakers have ambitious plans to catch up.

The German automobile industry is woefully behind in designing and selling electric vehicles (EVs), which consumers are increasingly taking to. It is not the Germans, supposedly the leading innovators in cars, but Renault-Nissan-Mitsubishi, a mass-market rival, that makes the world's bestselling EV, the Nissan Leaf, the sales of which have reached some 300,000 since the car's launch in 2010. Chinese carmakers are streets ahead.

"Made in Germany" has become a guarantee of engineering prowess that has helped to promote the country's exports of industrial equipment and a myriad of niche products. Around

four-fifths of all cars made in Germany, worth €256bn (US$283bn) in 2016, are exported. A workforce of around 800,000 is employed directly or by suppliers. In theory, German carmakers have the skills and cash to respond quickly, by building high-quality hybrid, plug-in or all-electric cars. Volkswagen says up to 25% of its cars sold in 2025 will be electrified. But they will not come cheap. EVs are pricier to make than those petrol-powered.

Source: *The Economist*, 1 March 2018

Extract 4: After electric cars, what more will it take for batteries to change the face of energy?

The demand for vehicle batteries is expected to overtake that from consumer electronics as early as in 2018. Huge expansion is under way. The top manufacturers of lithium-ion batteries—Japan's Panasonic, South Korea's LG Chem and Samsung SDI, are ramping up capital expenditure with a view to almost tripling capacity by 2020. Tesla is building with Panasonic in Nevada a new gigfactory that will vastly increase its production capacity in 2018. There have also been large amounts of R&D investment to improve power density (more storage per kilogram) and better durability (more discharge-then-recharge cycles) of the batteries.

The expansions have resulted in significant overcapacity. In 2016, the manufacturing capacity for lithium-ion batteries exceeded demand by about a third. The battery manufacturers were reported to either losing money or making only wafer-thin profits on every electric-vehicle battery they produce. Despite the seeming glut, though, they all have plans to expand, in part to drive prices even lower.

Source: *The Economist*, 12 August 2017

Suggested Answers

(a)	**Using examples from extract 1, distinguish between complements in demand and derived demand.**	**[2]**

Question requirements:

- ✓ *Identify examples from Extract 1 that shows complement in demand and derived demand.*
- ✓ *Explain the difference between complement in demand and derived demand.*

- **Lithium-ion batteries and electric vehicles are complements in demand** as lithium-ion battery is needed to run (used in conjunction/together) the electric vehicles
- On the other hand, **the demand for cobalt is derived from the demand for lithium-ion battery** as cobalt is needed to manufacture (used as an input to produce) lithium-ion battery.

Mark scheme:

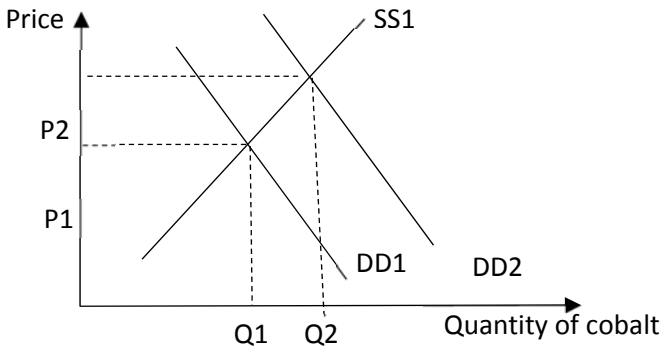
- ***1 mark for explaining that lithium-ion battery and electric vehicle are complements in demand.***
- ***1 mark for explaining that demand for cobalt is derived from the demand of lithium-ion battery.***

(b)	**Explain a factor that could be responsible for the trend in the global price of lithium-ion battery shown in Figure 1.**	**[2]**

Question requirements:

- ✓ *Identify a factor from extract 1 that has resulted in the increase in global price of cobalt.*
- ✓ *Explain that the increase in price is caused by an increase in demand and the magnitude of increase is influenced by the price elasticity of supply.*

- The increase in price of cobalt is due to an **increase in demand** as there has been an increase in the use of electric vehicles which requires cobalt in the manufacturing of lithium-ion batteries to power the electric vehicles.
- This resulted in a **rightward shift of the demand curve → shortage** of cobalt at the original equilibrium price → **upward pressure on price** → price increases.
- The sharp increase in price is due to the **supply of cobalt being price inelastic** as it takes time to mine the cobalt and most of the world's reserves and production of cobalt are in one country, the Democratic Republic of Congo (extract 1) → producers cannot respond to the price increase quickly and thus will increase price sharply to eliminate the shortage.



<u>Mark scheme</u>:

- ***1 mark for identifying demand for cobalt has increased due to increase in demand for electric vehicles and lithium-ion batteries. (use of case evidence)***
- ***1 mark for explaining how the increase in demand of cobalt leads to an increase in its price.***
- ***1 mark for explaining that the sharp increase in price is due to supply being price inelastic***
- ***1 mark for correct diagram.***

(c)	**Extract 2 mentions that the Chinese government is encouraging the production of electric vehicles.** **Explain how this policy can address the problem of market failure in the land transport market.**	**[5]**

Question requirements:

- ✓ *Explain the market failure in the land transport market.*
- ✓ *Explain how an increase in production of electric vehicles can tackle the market failure in the land transport market by recognizing that electric vehicle is a substitute of diesel/fuel based vehicles which cause air pollution and generate negative externality.*

- The use of diesel car generates negative externality as it emits harmful pollutants into the air, causing air pollution (extract 1) and deteriorate the health of third-parties whom do not received any compensation → marginal external cost is positive (MEC >0)
- The presence of negative externality causes a divergence between private marginal cost and marginal social cost as users of diesel car do not take into account the negative externality generated in their decision-making.
- The presence of negative externality will thus lead to the market failure due to over-allocation of resources as user of diesel car underestimated the true cost of using diesel car and the market price is too low to reflect this cost, leading to the equilibrium market output level to be higher than the socially-optimal output level. This cause deadweight loss to the society and thus the market of land transport fails. To address this problem, market equilibrium output of
- **Electric vehicles are substitutes for fuel-based vehicles.** By making electric vehicles cheaper to produce, consumers will switch demand away from fuel-based vehicles. Falling usage of fuel-based vehicles will reduce pollution levels and market failure.

Mark scheme:

- ***3 marks for explaining the problem of market failure due to air pollution in the land transport market.***
- ***2 marks for explaining how the increase in production of electric vehicle can address the market failure in the land transport market.***

(d)	**Account for the market structure which lithium-ion battery manufacturers are in.**	**[2]**

Question requirements:

- ✓ *Recognizing that market-concentration ratio is used to determine the market structure of an industry*
- ✓ *Explaining the market structure of the lithium-ion battery market using figure 2.*

- The lithium-ion battery market is oligopolistic in nature.
- The evidence is in Figure 2. It indicates the 4-firm concentration ratio of 77%, which means that a few firms dominate the industry.

Mark scheme:

- ***1 mark for identifying that the lithium-ion battery market is an oligopoly.***
- ***1 mark for using figure 2 to justify the market structure of the lithium-ion battery market.***

(e)	**Assess whether size expansion or research & development (R&D) is the better method for lithium-ion battery makers to expand their global market share.**	**[8]**

Question requirements:

- ✓ *Explaining how each strategy works on expanding market share (which tends to be in terms of sales value or revenue).*
- ✓ *Using valid criteria to consider which is a better method.*

Context: Unpacking what it means by expanding global market share and connecting to fundamental supply and demand principles

- Market share is usually measured based on a firm's sales revenue, or total revenue (TR).
- Strategies to raise TR can be understood in terms of supply or demand approaches. Strategies that raise demand will have direct positive effect on TR, while those that aim to raise TR through supply-side measures, such as by raising volumes in market and lowering price, the outcome will depend on the price elasticity of demand (PED) of the product.

Differentiating how the two strategies in the question work

- Size expansion suggests that the lithium-ion battery maker aims to benefit from the **internal economies of scale** → lowering average cost (AC) by expanding scale of production, either within a country or through overseas expansion.
- Overseas expansion can offer these further benefits:
    - o firm can lower its cost of production if resources or minerals it needs in production are cheaper in the destination country
    - o the country it's expanding in is also offering potential market.
- R&D on the other hand suggests that the lithium-ion battery maker is spending its resources not in investing into plant expansion, but it is **investing in innovation efforts**.
- R&D can be efficiency driven, to improve production method and lowering cost, or driven on the purpose of improving product range of quality. Firm in this case can be aiming **on lowering its AC or is aiming to producing higher quality goods which may involve higher AC.**

Examining the relative soundness of both methods (answer is free to use appropriate criteria of comparison but should remain linked to the objective of raising TR)

- Based on effectiveness in raising TR, R&D is necessary and more effective but is more affordable and cost effective for larger battery makers
    - o The use of lithium-ion batteries for electric vehicles (EVs) offers great **demand expansion**, as mentioned in Extract 4. Consumers are looking for batteries that have power density and durability, so that EVs can run longer for each charging and each battery has longer life-cycle.
    - o With high battery quality, a firm will have **low PED** of its products →the ability to charge higher prices and gain TR increases.
    - o By this criterion, **R&D investment will be necessary and effective** for a battery maker to spur its demand.
    - o However, smaller battery makers with far smaller market shares shown in Figure 2, which are Wanxiang, GS Yuasa and Lishen, will not be able to afford the large R&D investment as they will incur higher fixed cost. These battery makers may then **focus on lower range lithium-ion batteries to first gain the economies of scale from mass market**. It is likely

that these firms will have **more price elastic demand, hence charging lower prices will be needed to expand their market share.**
    - **Collaborative R&D** effort is also possible for these smaller firms. They can then apply their own distinct branding strategies to the results of the collaborative R&D.
- Based on sustainability in raising TR, size expansion is necessary to make future R&D and marketing strategies more cost effective
    - Although R&D is more effective for producing premium quality batteries that can fetch high prices and market expansion, size expansion is **necessary too for all firms to gain from economies of scale.**
    - Even the most dominant firms such as Panasonic Sanyo will need to expand their plant capacity to lower AC because **in globally competitive markets both quality and price matter.** Which this firm may be in premium market, it is susceptible to competition from the close rivals such as BYD and LG Chem.
    - No firms can rest on the assumption that they can continue expanding market through quality and high prices alone. Extract 3 explains how Germany, a global leader in auto industry has been threatened by mass market EVs.

Synthesizing

- As EV makers look for lithium-ion batteries that offer both high density and durability, battery makers need to invest in R&D for such qualities. This will raise demand and enable them to adopt premium pricing, both raising global market share.
- But R&D and size expansion are mutually interdependent, both are needed for a R&D to be cost effective and sustainable.
- The battery makers with much smaller market share will find R&D a challenging strategy and may focus more on size expansion at the beginning stage to make their strategies they are adopting more cost effective. This will entail a mass market focus too.

L2	• Applying some economic concepts in explaining the two strategies • Explicit linking to qualities needed for EVs (source of demand expansion for lithium-ion batteries) • Using case study information, such as Figure 2 and Extract 4	4-6
L1	• Explanation is more intuitive and lacking the conceptual support (not referring to internal economies of scale or PED as basis of explanation) • Not linking the qualities needed for lithium-ion batteries to requirements from EV market (density and durability)	1-3
E2	A coherent judgement which ends with an appropriate synthesis • Using a criterion, such as effectiveness or affordability, to determine which is better • Able to make a considered statement after comparing the two strategies, examples: o R&D is more effective but only affordable for battery maker with larger market share o Both are necessary strategies and the issue of better applies to which is made a greater emphasis in the short term	2

	E1	A judgement that does not end with an appropriate synthesis • Judgement may be at random and not with a clear criterion • No sound considered statement at the end of answer	1

(f)	**Discuss whether Germany should adopt similar policies as China to maintain the profitability of Germany's car manufacturers.**	**[10]**

Answer requirements:

- ✓ *Identification of the policies adopted by China and explanation of how these are meant to support China's EV manufacturers.*
- ✓ *Using clear criteria in examining the appropriateness of these policies in the context of Germany.*

Identifying and explaining the policies China adopted for to expand the country's EV production

- Extract 2 mentions that China provided generous **subsidies in different forms,** such as to parts suppliers and to buyers of domestically made EVs.
- Simultaneous, the Chinese government is also supporting the **growth of innovations which are EV-related**. The examples mentioned point to innovation to make EVs internet-connected.
- It appears that **these two measures work on both the supply and demand sides of the industry.** The subsidies will absorb part of the production cost of EVs, hence making them cheaper in the market, while the innovation and tie-ups with internet giant companies are meant to also enhance the quality and demand for its EVs.
- **State-support** is obvious in the expansion of EV industry in China.

Justifying the support for state support in the context of German car industry

- Macroeconomic benefits: German is a global leader in the manufacturing of premium cars. Extract 3 mentions that in 2016, four-fifths of its cars were exported and the industry employed 800,000 workers. If EV cars can produced cheaper and better in other countries, **German economy will suffer significantly from the decline in its comparative advantage in technically supreme fuel-based cars.**
- While German car makers have started making EVs, these currently are more expensive than fuel-based ones and **they lag behind American and Chinese made EVs.**
- Greater environmental awareness and improving quality and lowering prices of lithium-ion batteries will lead to rising demand for EVs, which means German car industry and economy are threatened. **This can justify the need for state support to the industry.**

Considering the appropriateness of the state support

- However, state support for an industry's expansion is known to cause undesirable efficiency outcomes.
- **Efficiency** consideration: Supporting an industry **will weaken manufacturers' drive for competitiveness and innovation.** If a car maker can sell cheaper because of state subsidy, it will lack the drive to make its production cost lower through efficiency and innovation. Extract 2 mentions of China-made EVs being of poor design and quality.
- **Capacity** consideration: Being global market leaders of premium cars, German car makers should have the capacity to be inventive in EV market. Extract 3 mentions about these car makers having the skills and cash to build high-quality hybrid or pure EVs.

- Financial support to the industry may also be conceived by other countries as a **protectionist strategy** and this will invite uncalled for retaliation. China's state support for its industries has been known to upset its trade partners and cause retaliatory trade restrictions such as from US.

Synthesizing

- The importance of car industry in German's economy and the threats from the developments in EV and lithium-ion battery productions might point to the necessity of German government extending support to the country's car makers.
- However, from efficiency point of view, it is far more effective for competitiveness to be market and not state driven. The issues of reliance and outflow of government funds will mean that German car makers, which are globally strong producers, should be let to find their global market niche on their own efforts. If government support is to be given, this should be in areas which are considered hugely expensive but considered critical to German car industry as a whole and not distinct to EV production.

L2	• Provides economic support to the two strategies Chinese government adopted for the country's EV industry, e.g. how these address demand and supply sides of the market • Balanced view in considering whether state support is appropriate in the context of Germany • Using case study materials, such as Extracts 2 and 3, in discussion	5-7
L1	• Considering the strengths and weaknesses of state support in making an industry globally competitive but the discussion lacking in depth, e.g. not considering that German is global leader in fuel-based car making and it will not be appropriate to support the industry to just be a mass market EV producers • Mostly one-sided view of the issue of state support	1-4
E2	• 3 marks for answers that end with a sound conclusion, such as o To be globally competitive producers, firms need to rough it out with their market-driven strategies o German government may have to support innovation in EV production considering that the economy is very dependent on car manufacturing but is currently lagging behind in global EV market • Sound criteria used in examining the issue of state support for growth of industries	2-3
E1	• Without a coherent direction in evaluation • Judgement made is at random, answer is mostly lacking in statements of opinions supported with sound economic reasoning	1