Subject: **Chemistry / Physics**

Topic: **CO_2 from human activity / Forces**

Application: **Electric aircraft**

Using the worksheet and podcast resources

This worksheet is based on the Inventive podcast.

It supports Gatsby Benchmark 4: Careers in the curriculum by introducing a career and role model. The worksheets are based on topics in the KS3 curriculum.

The short audio clips can be used to provide context to the worksheet and could be played during a lesson.

A QR code on the student sheet links directly to the podcast.

KS3 National Curriculum statements

Chemistry

- The carbon cycle;
- The composition of the atmosphere;
- the production of carbon dioxide by human activity and the impact on climate.

Physics

- Forces: resistance to motion of air and water;
- Non-contact forces: gravity forces acting at a distance on Earth.

Audio clips from Inventive podcast.

- **Sophie Clip 1** Describing the design of the aircraft. *This clip is useful when answering Q5;*
- **Sophie Clip 2** Benefits and limitations of electric aircraft used as taxis. *This clip is useful when answering Q4.*

Other resources

Sophie's career poster

More information about Sophie

Meet the engineer

Sophie Robinson

Flight dynamics engineer

Sophie Robinson is the senior flight dynamics engineer for a company that designs air taxis - aircraft used to travel short distances in cities. Sophie works on aircraft that take-off and land vertically and use batteries. She is responsible for modelling how the aircraft will fly, and studies the performance of the aircraft including how moving the controls changes its motion.

Scan the QR code

to access all the resources and the full podcast from: *nustem.uk/inventive/#sophie*

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This work was supported by EPSRC Engineering and Physical Sciences Research Council

Know

1. Carbon Dioxide (other correct answers include water vapour, methane. Do not accept ozone).

2. Release greenhouse gases: oil, gas, coal, petrol, diesel, biomass -
Do not release greenhouse gases when in use: Solar, wind, hydroelectricity (waves, tidal) (although note that new hydroelectricity schemes submerge vegetation which rots, and manufacture of equipment does produce greenhouse gases).

3. Carbon dioxide is a **greenhouse** gas. Greenhouse gases trap heat in the **atmosphere** so global temperatures increase. **Global** warming cause **climate** change, for example more heatwaves and storms.

Apply

4. Less pollution/carbon dioxide at point of use; fewer fossil fuels burned if electricity is generated from renewable sources; reduces local congestion (so other drivers emit less pollutants).

5a. Weight, air resistance (accept any other correct answer).
5b. Upwards because weight acts downwards.
5c. Forwards and upwards because air resistance acts backwards and weight acts down.

Extend

6a. Any correct ideas. For example: carbon free - no net carbon dioxide is released using the air taxi/ charging its batteries.

6b. Any correct ideas. For example: use renewable energy resources (not biomass) to generate electricity to charge batteries.

7a. 160km/200 km per hour = 0.8 hours or 48 minutes.

7b. E.g. - speed it travels (affects air resistance), wind speed, how it takes off or lands, etc.

Worksheet version: 2.0, 2022-06

Energy resources and the Earth's atmosphere

Sophie is helping to design an electric aircraft The electricity used to charge the aircraft batteries can be generated using different resources.

Fossil fuels (oil, gas and coal) took millions of years to form and are non-renewable. When burnt, fossil fuels release carbon dioxide and other gases. Carbon dioxide is a greenhouse gas.

Greenhouse gases in the atmosphere cause global warming, a world-wide rise in temperature. Global warming leads to long-term changes in weather, called climate change.

Wind, solar and biomass are renewable energy resources. They can be replaced within a reasonable time-scale.

Using wind turbines, hydroelectricity, and solar power to generate electricity won't release greenhouse gases when they are being used but burning biomass does.

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Link to Sophie's story

Know

1. Name one greenhouse gas.

2. Write down 2 energy resources that release greenhouse gases and 2 energy resources that do not.

3. Carbon dioxide in the atmosphere is linked to climate change. Use the following words to fill in the gaps to complete the sentences which explain why:

atmosphere, climate, global, greenhouse

Carbon dioxide is a _____ gas. Greenhouse gases trap heat in the _____ so global temperatures increase. _____ warming causes _____ change, for example more heatwaves and storms.

Apply

4. Most vehicles like planes, trains, lorries and cars burn fossil fuels like kerosene, petrol or diesel. Electric vehicles use a rechargeable battery that can be charged using electricity from renewable resources. This reduces the amount of carbon dioxide and pollution released.

State two advantages to the environment of using electric air taxis instead of diesel-powered air taxis.

5. The air taxi has rotors on its wings. The rotors produce a thrust force and the direction of this force can be changed.

Source: www.vertical-aerospace.com

5a. What other forces affect the air taxi when it is flying at a constant height?

5b. Suggest, and explain, what the direction of the thrust from the rotors is when the taxi takes off vertically.

5c. Suggest and explain which direction the thrust from the rotors must tilt when the taxi cruises (flies at a constant height)?

Extend

6. Sophie's company wants to make air travel 'carbon free'.

6a. Suggest what is meant by the phrase 'carbon free'.

6b. Describe how a company could make a journey by electric air-taxi carbon free at the point of use.

7. The air taxi has a cruising speed of 200 km/hour. The maximum distance it can travel is 160 km.

7a. Use this information to estimate the time the air taxi can stay in the air at cruising speed.

7b. Suggest factors that could change the amount of time spent in the air by the taxi.

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