4 (a) Figure 8 shows an airport worker refuelling an aircraft.

(Source: © Stanisław Tokarski/123RF)

Figure 8

(i) Pumping fuel into an aircraft can be dangerous.

The worker connects an earth wire to the aircraft before pumping fuel.

Give **one** reason why earthing reduces the risk of fire.

(1)

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(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

time = ... s

(c) Figure 9 shows an electrostatic method for spray-painting a car door.

The car door has a negative charge.

The droplets of paint receive a positive charge as they leave the spray gun.

(Source: © Jens Brüggemann/123RF)

Figure 9

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

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(Total for Question 4 = 8 marks)

Question number	Answer	Mark
4(a)(i)	The earth wire discharges the aircraft to prevent sparking which could ignite the fuel/cause a fire	(1)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • friction between aircraft and air (1) • causes electron transfer between aircraft and air (1)	accept idea of air rubbing against wings ignore 'charge' and 'static' do not allow (for second mark) idea of protons moving	(2)

Question number	Answer	Additional guidance	Mark
4(b)	Equating energy in both equations (1) E = weight × height = power × time Rearrangement (1) time = $\frac{(\text{weight} \times \text{height})}{\text{power}}$ Substitution and evaluation (1) time = 230 000 × $\frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	**(3)**

Question number	Answer	Mark
4(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • (negatively charged) door attracts (positively charged) paint (droplets) (1) Plus any **one** of the following: • therefore (positively charged) paint (droplets) follow lines of force and coat both sides of the car door (1) • since electric field (or lines of force) directed towards the (car) door, then positive paint will move to the door (1) • as electric field (or lines of force) touches all parts of the (car) door hence the positive paint will coat all parts of the door (1)	**(2)**