7 (a) Balloon **P** hangs from an insulating thread.

A teacher gives the balloon a positive electric charge, as shown in Figure 15.

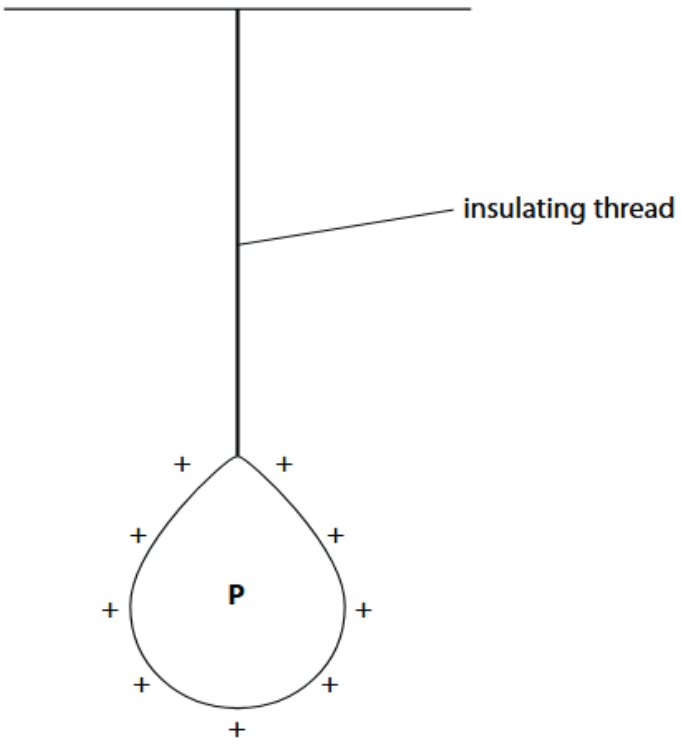

Figure 15

(i) When the balloon is charged like this, it has

(1)

- ☒ **A** gained electrons
- ☒ **B** lost electrons
- ☒ **C** gained protons
- ☒ **D** lost protons

(ii) Two more balloons, **Q** and **R**, are charged and placed either side of balloon **P**.

The balloons move to the positions shown in Figure 16.

Add the charges on balloons **Q** and **R** in Figure 16.

(2)

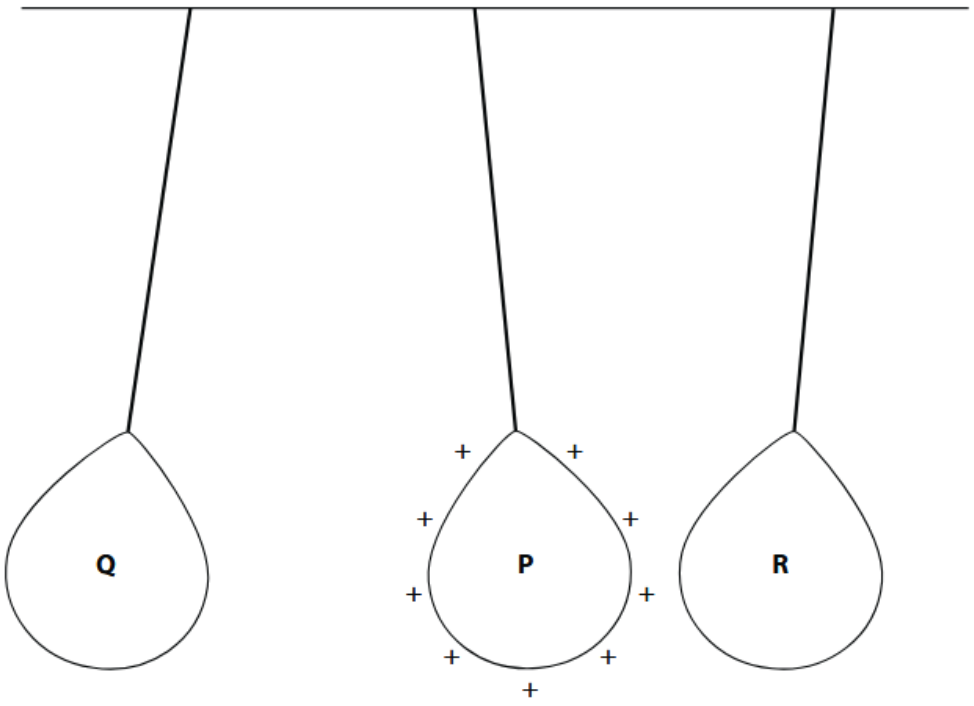

Figure 16

(b) Figure 17 shows an airport worker refuelling an aircraft.

(Source: © Stanisław Tokarski/123RF)

Figure 17

(i) As fuel moves through the pipe, it becomes positively charged.

Explain how the worker can prevent a build-up of charge when pumping fuel into the aircraft.

(3)

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

(2)

.....

.....

.....

.....

(c) 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

(Total for Question 7 = 11 marks)

Question number	Answer	Mark
7(a)(i)	B	(1)

Question number	Answer	Additional guidance	Mark
7(a)(ii)	• label to indicate that balloon Q has a positive charge (1) • label to indicate that balloon R has a negative charge (1)	accept responses showing appropriate +/− signs or worded label	(2)

Question number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (2 marks): • use of a conductor to connect between aircraft and ground (1) • allowing negative charge to move onto the aircraft (1) • therefore neutralising the positive charge(s) (1)	accept (copper) wire accept earth for ground	(3)

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

Question number	Answer	Additional guidance	Mark
7(c)	equating energy in both equations (1) E = weight × height = power × time rearrangement (1) time = $\frac{(\text{weight} \times \text{height})}{\text{power}}$ substitution and answer (1) time = 230 000 × $\frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	**(3)**