1 A shopping centre has escalators to move people between floors.



(a) A man of mass 78 kg steps on to an escalator.

The escalator lifts him a height of 5.0 m.

(i) State the equation linking gravitational potential energy, mass, *g* and height.

(1)

(ii) Show that the gravitational potential energy gained by the man is about 4000 J.

(2)

(iii) State the work done on the man and give the unit.

(2)

Work done = ... Unit .....

(b) The escalator is powered by a 7.5 kW electric motor.

(i) State the equation linking efficiency, useful energy output and total energy input.

(1)

(ii) The escalator lifts 30 people each minute.

Each person has a mass of 78 kg.

Calculate the efficiency of the escalator.

(3)

Efficiency = ...

(c) Another escalator has an efficiency of 20%.

Its input power is 15 kW.

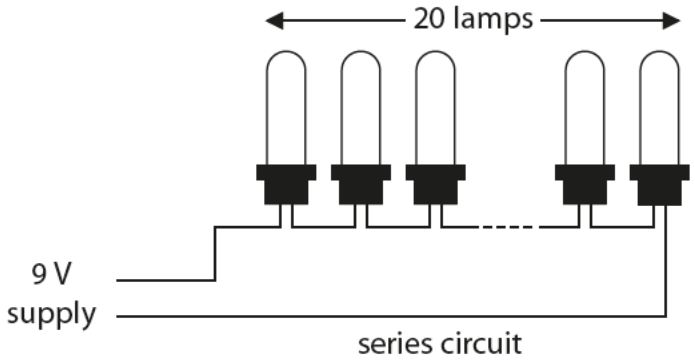
Draw a Sankey diagram for this escalator.

(3)

(Total for Question 1 = 12 marks)

2 The diagram shows some lamps connected together.

There are 20 small lamps connected in series with a 9 V supply.



(a) (i) What is the voltage across each lamp in the series circuit?

(1)

.....

(ii) Each lamp has a power of 1.5 W.

State the equation linking power, current and voltage.

(1)

(iii) Show that the current in the circuit is about 3 A.

(2)

(b) (i) The lamps are on for 7 hours a day for 5 days.

Calculate the total energy transferred during this time.

(3)

energy transferred = ... J

(ii) Describe the energy changes that take place in the lamps when they are connected to the power supply.

(2)

.....

.....

.....

.....

(Total for Question 2 = 9 marks)

3 The photograph shows a small aeroplane, of mass 600 kg.



This aeroplane has an electric motor powered by fuel cells.

Fuel cells use hydrogen gas and provide an electric current.

(a) When the aeroplane is working, the energy changes are

(1)

☒ **A** chemical → electrical → kinetic

☒ **B** electrical → chemical → kinetic

☒ **C** electrical → kinetic → chemical

☒ **D** kinetic → chemical → electrical

(b) The velocity of the aeroplane is 28 m/s.

(i) State the equation linking kinetic energy, mass and velocity.

(1)

(ii) Calculate the kinetic energy of the aeroplane.

(2)

Kinetic energy = ... J

(c) The aeroplane takes off and climbs to a height of 1000 m.

(i) State the equation linking gravitational potential energy (GPE), mass, *g* and height.

(1)

(ii) Calculate the gravitational potential energy gained by the aeroplane.

(2)

GPE of the aeroplane = ... J

(iii) The fuel cells provide a maximum total power of 24 kW. The aeroplane also carries a large rechargeable battery.

Show, by calculation, that the aeroplane needs this extra source of power to climb to 1000 m in 3 minutes.

(2)

(iv) The aeroplane uses fuel cells connected together in series in a 'stack'.

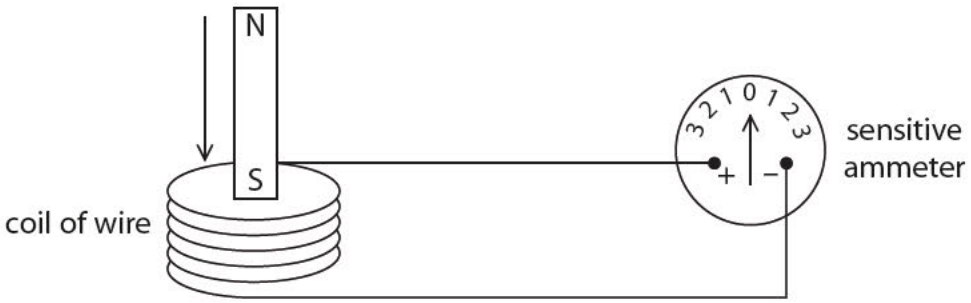
The voltage of each fuel cell is 0.6 V. The maximum current in each fuel cell is 30 A.

Show that there must be more than 1300 fuel cells in the stack.

(2)

(Total for Question 3 = 11 marks)

4 (a) A student uses this apparatus to investigate electromagnetic induction.



When the S pole of the magnet is moved into the coil, the pointer on the sensitive ammeter moves to the left.

Describe two ways that the student can make the pointer move to the right.

(2)

1 .....

.....

2 .....

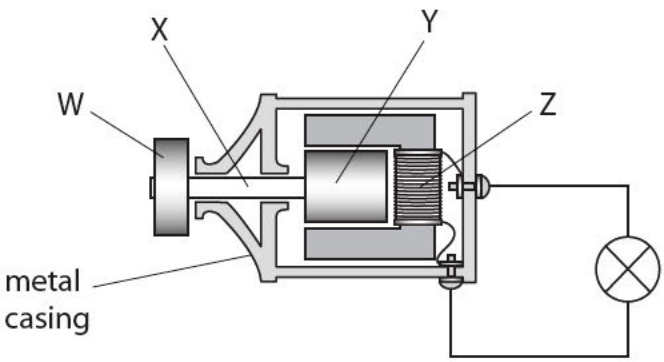
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(b) The student has a bicycle with a dynamo (generator) that supplies electricity for its lights. The diagram shows the dynamo.

The friction wheel, W, presses against the bicycle tyre. When the student pedals, the friction wheel turns and causes part Y to rotate.

Key

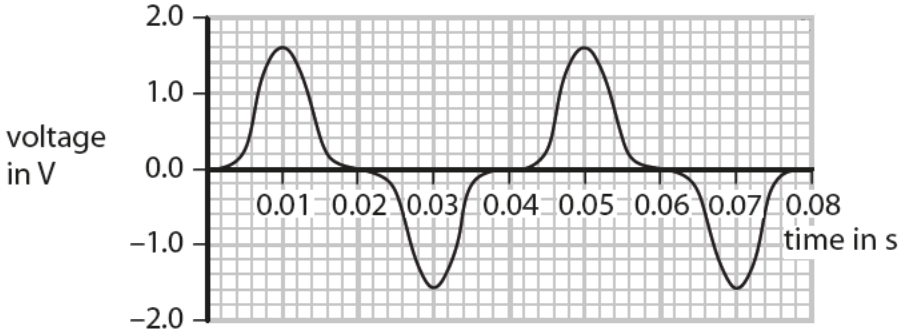
W	friction wheel
X	axle
Y	
Z	



(i) Complete the key for the diagram by giving the names of parts Y and Z.

(2)

(ii) The graph shows how the output voltage of the dynamo varies with time as the student pedals steadily.



State the maximum output voltage of the dynamo.

(1)

maximum output voltage = ... V

(iii) Calculate the frequency of the output voltage.

(2)

frequency = ... Hz

(iv) Which row of the table is correct when the friction wheel turns faster?

(1)

	Output voltage is	Frequency of output voltage is
☒ **A**	lower	lower
☒ **B**	higher	lower
☒ **C**	higher	higher
☒ **D**	lower	higher

(v) Apart from changing the speed of the friction wheel, suggest how the output voltage of the dynamo can be increased.

(1)

.....

.....

(c) The student cycles for 290 s.

Her dynamo produces a constant useful power output of 3.1 W and is 72% efficient.

(i) Calculate the total useful energy output.

(3)

useful energy output = ... J

(ii) State the relationship between efficiency, useful energy output and total energy input.

(1)

(iii) Calculate the total energy input.

(3)

total energy input = ... J

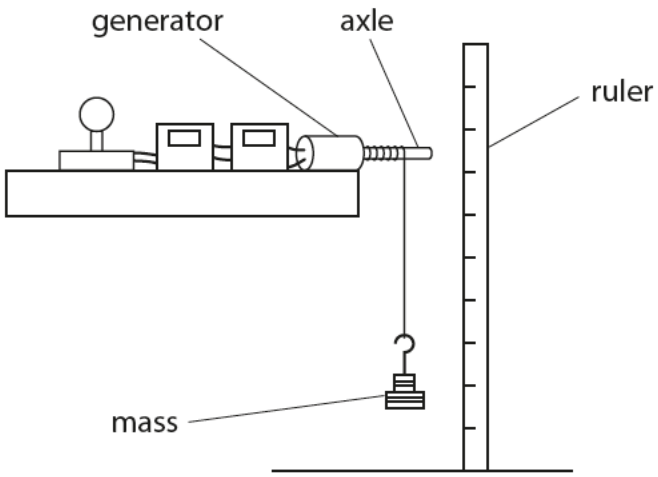
(Total for Question 4 = 16 marks)

5 (a) A student investigates the energy transfers in a small generator.

She connects the generator to a circuit that includes a lamp.

She hangs a mass from a string wound around the axle.

The lamp lights as the mass falls to the ground.



The table shows the student's results.

height that mass falls	0.61 m
mass	2.75 kg
time taken for mass to fall	1.3 s
average current in the lamp	0.46 A
average voltage across the lamp	12.7 V

(i) State the equation linking gravitational potential energy, mass, *g* and height.

(1)

(ii) Calculate the gravitational potential energy, GPE, lost by the mass.

(2)

GPE = ... J

(iii) Explain why only some of the gravitational potential energy of the mass is transferred to the lamp.

(2)

.....

.....

.....

.....

(iv) Calculate the energy transferred to the lamp.

(2)

energy transferred = ... J

(b) Water from a reservoir can be used to generate electricity on a large scale.

Describe the energy transfers involved in this process.

(3)

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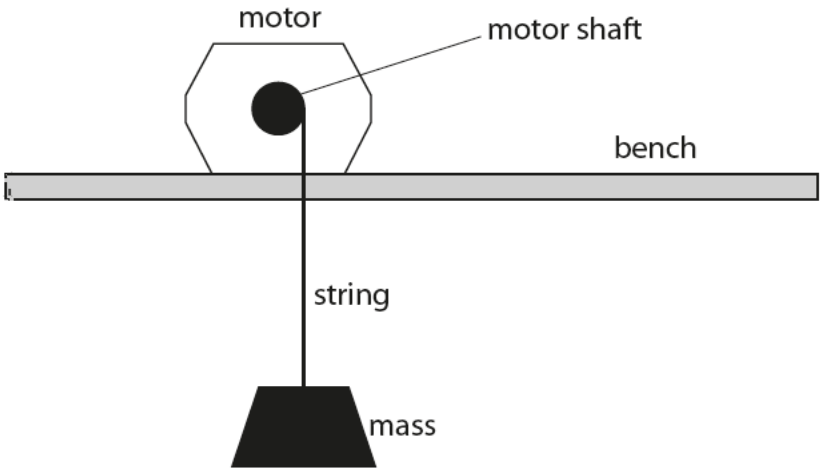
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(Total for Question 5 = 10 marks)

6 A student investigates the efficiency of an electric motor.



She uses the motor to lift a mass.

The table shows her measurements.

Current in motor	1.3 A
Voltage across motor	10.3 V
Time taken to lift mass	4.7 s
Force needed to lift mass	20 N
Distance the mass was lifted	0.85 m

(a) Calculate the electrical energy supplied to the motor during this time.

(2)

energy supplied = ... J

(b) (i) State the equation linking work done, force and distance moved.

(1)

(ii) Calculate the work done on the mass.

(2)

work done = ... J

(iii) State the useful energy transferred to the mass.

(1)

.....

(c) (i) State the equation linking efficiency, useful energy output and total energy input.

(1)

(ii) Calculate the efficiency of the motor.

(2)

efficiency = ...

(Total for Question 6 = 9 marks)