Mark schemes

1. (a) Initial temperature was a control variable

1

(b) copper

1

greater change in mass (than the other metals)

this mark is dependent on scoring the first mark

allow more ice melted (than the other metals)

allow the ice melted faster (than the other metals)

1

(c) variation in initial mass of ice cube

allow variation in initial volume of ice cube

or

surface area of the ice cube touching the metal

allow melting of ice while handling

allow variation in room temperature

allow initial temperature of metal block

1

(d)

*an answer of 0.016 (kg) scores **5** marks*

E = m × 2100 × 15

1

E = m × 334 000

1

5848 = 31 500 m + 334 000 m

or

5848 = 365 500 m

1

$$m = \frac{5848}{(31\,500 + 334\,000)}$$

or

$$m = \frac{5848}{(365\,500)}$$

1

m = 0.016 (kg)

*allow **2** marks for an answer that rounds to 0.186 or 0.0175*

*if no other mark scored allow **1** mark for either*
5848 = m × 2100 × 15
or
5848 = m × 334 000

1

[9]

2. (a) $E = \frac{1.25 \times 10^{18}}{3.16 \times 10^{7}}$

1

E = 3.96×10^{10} (J)

*an answer that rounds to 3.96×10^{10} (J) scores **1** mark*

1

(b) t = 86 400 (s)

1

27 000 = I × 86 400

allow a correct substitution of an incorrectly/not converted value of t

1

$$I = \frac{27\,000}{86\,400}$$

allow a correct rearrangement using an incorrectly/not converted value of t

1

I = 0.3125 (A)

allow a correct calculation using an incorrectly/not converted value of t

allow a correctly calculated answer rounded to 2 or 3 sf

1

(c) $0.15 = \frac{\text{useful power output}}{7800}$

allow a correct substitution of an incorrectly/not converted value of total power input

1

useful power output =
0.15 × 7800

allow a correct rearrangement using an incorrectly/not converted value of total power input

1

useful power output = 1170 (W)

this answer only but allow 1200 (W) if correct working shown

1

(d) a really large area of land would need to be covered with solar cells

1

due to the low useful power output of the solar cells

allow due to the low efficiency of the solar cells

or

number of hours of daylight is too low (in UK)

or

low solar intensity (in UK)

or

solar radiation (in UK) is too low

or

material for construction of solar cells and/or lithium batteries is in limited supply

1

[11]

3. (a) the total energy of the racing track and the car is constant.

1

(b) $E_p = 0.040 \times 9.8 \times 0.90$

allow a correct substitution of an incorrectly/not converted value of h

1

$E_p = 0.3528$ (J)

this answer only

1

$0.3528 = 0.5 \times 0.040 \times v^2$

allow a correct substitution of a calculated E_p

1

$$v^2 = \frac{0.3528}{0.5 \times 0.040}$$

allow a correct rearrangement using a calculated E_p

1

$v = 4.2$ (m/s)

allow an answer consistent with their calculated E_p

1

(c) more than 0.20 J

1

(because) the car needs to be moving at the top of the loop
or
(because) the car needs to be moving to complete the loop
or
not all E_k at **B** will be transferred to E_p at **C**

this mark is dependent on scoring the first mark

allow energy dissipated to the surroundings

1

[8]

4. (a) electric car journey will take a (much) longer time

allow diesel car journey will take a shorter time

1

(because) battery will need recharging
or
(because) the car will need to stop for 40 minutes

allow diesel car will not need to be refuelled

1

(b) energy stored in diesel = 45 × 51 = 2295 (MJ)

1

energy stored in batteries = 0.95 × 280 = 266 (MJ)

1

(so) the diesel stores more energy than the battery (and the diesel car has a higher range)

this mark is dependent on correct calculations of energy stored

1

(c) any **2** from:

- recharging is a continuous process

  allow cars do not need to stop to recharge

  allow shorter journey times

  allow don't have to wait for battery to recharge

  allow longer time between recharges

  allow the range of the electric car is increased

- fewer cells needed in the car

  allow smaller battery needed in the car

- more cars can be charged at the same time

  allow do not need to find a charging point

  allow fewer charging stations needed
  ignore it is quicker
  ignore cost of charging
  ignore methods of electricity generation

2

(d) when cars are plugged in

the energy from car batteries could be transferred back to the National Grid

1

allow mains supply for National Grid

allow energy from car batteries could be used to power household appliances

1

[9]

5. (a) Length of sled

1

Time for sled to pass light gate

1

(b) $E_p = 8330$ (J)

1

$8330 = m \times 9.8 \times 17.0$

allow a correct substitution using an incorrectly/not converted value of E_p

1

$m = \frac{8330}{9.8 \times 17.0}$

allow a correct rearrangement using an incorrectly/not converted value of E_p

1

$m = 50.0$ (kg)

allow a correct calculation using an incorrectly/not converted value of E_p

1

(c) $\frac{1}{2} mv^2 = mgh$
or
decrease in E_p = increase in E_k

1

masses cancel on both sides of the equation
or
$v^2 = 2gh$

1

(final) speed only depends on vertical height (and gravitational field strength)

1

variations will be due to air resistance/friction
or
different initial speed

1

[10]

6. (a) % increase = $\frac{(10\,000 - 3200)}{3200} \times 100$

1

% increase = 212.5 (%)

1

(b) Any **two** from:

- no sulfur dioxide released
- doesn't cause acid rain
- no particulates released
- doesn't cause global dimming
- less carbon dioxide released (per kg of fuel burned)
- less global warming

  allow less climate change

  allow less greenhouse gases
- no solid waste
- gas mining is less destructive than coal mining

  ignore less air pollution

2

(c) mean sea surface temperature shows a (steady) increase

1

over the time period on the graph

conditional on scoring 1st marking point
allow between a correct pair of dates at least 10 years apart

or

from 16.45 (°C) to 16.96 (°C)

allow a correct pair of temperatures at least 10 years apart

1

(d) thermistor C

1

(because) the change in resistance is greatest

conditional on scoring 1st marking point
allow the gradient is highest
allow more sensitive to temperature change

1

between 0 and 25 ºC

conditional on scoring 2nd marking point
allow between 16 and 17 °C
if thermistor C is not chosen, allow for 1 mark each:
not thermistor A because there is no/little change in resistance
not thermistor B as there is only a small change in resistance
not thermistor D as there is no data available between 0 and 40 °C

1

[8]

7. (a) 50

1

Hz / hertz

allow Hertz

1

(b) (both) switches need to be closed / on

1

to complete the series circuit
or
to allow charge to flow
or
so there is a current in the circuit

1

(c)

*an answer of 7.5 (A) scores **3** marks*

*an answer of 0.237(A) scores **2** marks*

$1800 = I^2 \times 32$

this mark may be awarded if P is incorrectly or not converted

1

$I^2 = \frac{1800}{32}$

or

$I^2 = 56.25$

this mark may be awarded if P is incorrectly or not converted

1

I = 7.5 (A)

this answer only

1

(d)

*an answer of 300 (s) scores **3** marks*

*an answer of 300 000 (s) scores **2** marks*

$1500 = \frac{450\ 000}{t}$

this mark may be awarded if P is incorrectly or not converted

1

$t = \frac{450\ 000}{1500}$

this mark may be awarded if P is incorrectly or not converted

1

t = 300 (s)

this answer only

1

[10]

8. (a) the heating element of the kettle takes time to heat up

allow the kettle takes time to heat up

1

(b) $\Delta\Theta = 78$ (°C)

1

$155\ 000 = m \times 4200 \times 78$

allow a correct substitution using an incorrect value of $\Delta\Theta$

1

$m = \frac{155\ 000}{4200 \times 78}$

allow a correct rearrangement using an incorrect value of $\Delta\Theta$

1

m = 0.4731 (kg)

allow a correct calculation of mass using an incorrect value of $\Delta\Theta$

1

m = 0.47 (kg)

1

(c) Gradient = $\frac{\Delta\theta}{t}$

allow gradient = rate of temperature increase
allow calculation of gradient

1

$Pt = mc\Delta\Theta$

1

P = gradient × mc

1

[9]

9. (a)

*an answer of 2.5 (m) scores **3** marks*

$1470 = 60 \times 9.8 \times h$

this mark may be awarded if E_p is incorrectly / not converted

1

$h = \frac{1470}{60 \times 9.8}$

or

$h = \frac{1470}{588}$

this mark may be awarded if E_p is incorrectly / not converted

1

h = 2.5 (m)

this answer only

1

(b) (work done against) air resistance
or
(work done against) friction (between zip line and pulley)

1

causes thermal energy to be transferred to surroundings

ignore sound energy

1

(c) different people have different surface areas

allow streamlining

allow body position

body size is insufficient

1

so would be affected by air resistance differently

or

initial speed may not be zero (1)

which would add to the total energy (of the system) (1)

allow people have different masses / weights (1)

so people have different terminal velocities (1)

reference to mass changing the kinetic energy or gravitational potential energy negates both these marks

1

[7]

10. (a) chemical

1

equal to

allow the same as

1

in this order only

(b) $\text{power} = \frac{\text{work done}}{\text{time}}$

allow $P = \frac{W}{t}$

1

(c) $200 = \frac{W}{1800}$

1

W = 200 × 1800

1

W = 360 000 (J)

1

*an answer of 360 000 (J) scores **3** marks*

(d) 11 − 9.5 = 1.5 (m/s)

allow a change in speed between 1.2 and 1.5 (m/s)

1

$\left(\frac{1.5}{9.5}\right) \times 100 = 15.8\,(\%)$

allow an answer consistent with their change in speed

*an answer of 16 (%) scores **2** marks*

1

*an answer that rounds to 15.8 (%) scores **2** marks*

(e) maximum speed is lower

1

because maximum power output of cyclist is constant

allow maximum force on pedals is constant

1

(but) additional work is done (against gravity)

*do **not** accept additional work done against friction or air resistance*

or

gravitational potential energy (of cyclist) is increased

1

[11]

11. (a) risk of electric shock (if someone touched the case)

allow risk of electrocution (if someone touched the case)

1

(b) 2530 = I × 230

this mark may be awarded if P is incorrectly / not converted

1

$I = \frac{2530}{230}$

this mark may be awarded if P is incorrectly / not converted

1

I = 11 (A)

this answer only

*an answer of 0.011 (A) scores **2** marks*

1

*an answer of 11 (A) scores **3** marks*

(c) E = 2530 × 14

this mark may be awarded if P is incorrectly / not converted

1

E = 35 420 (J)

this answer only

1

35 420 = m × 4200 × 70

allow their calculated E = m × 4200 × 70

1

$$m = \frac{35\,420}{4200 \times 70}$$

allow $m = \frac{\text{their calculated } E}{4200 \times 70}$

1

m = 0.12 (kg)

allow an answer that is consistent with their calculated value of E

1

[9]

12. (a) any **three** from:

- no carbon dioxide emitted (to produce electricity)

  no greenhouse gases is insufficient

- doesn't cause global warming

  allow climate change or greenhouse effect for global warming

- nuclear power doesn't cause earthquakes
- more energy released per kg of fuel (compared to shale gas)

3

(b) uranium
or
plutonium

ignore any numbers given

1

(c) a neutron is absorbed by a (large) nucleus

a description in terms of only atoms negates first two marking points

1

the nucleus splits into two (smaller) nuclei

1

releasing energy (and gamma rays)

1

and (two / three) neutrons

1

[8]

13. (a) $1.2 = \frac{m}{2.3 \times 10^4}$

1

$m = 1.2 \times 2.3 \times 10^4$

1

m = 27 600 (kg)

allow an answer of 28 000 (kg) or 2.8 × 10^4 (kg)

or

$m = 2.76 \times 10^4$ (kg)

1

*an answer of 27 600 (kg) scores **3** marks*

(b) mass of air passing the turbine blades is halved which decreases kinetic energy by a factor of two

1

(wind speed is halved) decreasing kinetic energy by a factor of four

1

so kinetic energy decreases by a factor of eight

1

allow power output for kinetic energy throughout

(c) $388\,000 = 0.5 \times 13\,800 \times v^2$

this mark may be awarded if P is incorrectly / not converted

1

$$v^2 = \frac{(2 \times 388\,000)}{13\,800}$$

this mark may be awarded if P is incorrectly / not converted

or

$$v^2 = \frac{388\,000}{(0.5 \times 13\,800)}$$

or

$v^2 = 56.2$

1

v = 7.50 (m/s)

an answer that rounds to 7.50 (m/s) only

1

[9]

14. (a) potential difference

allow p.d.
allow voltage

1

temperature

1

in this order only

(b) the current increases (when the potential difference increases)

1

(which) causes the temperature of the filament to increase

1

(so) the resistance increases

*do **not** accept resistance increases and then levels off*

1

(c) a higher proportion / percentage of the (total) power / energy input is usefully transferred

wastes less energy is insufficient

or
higher (useful) power / energy output for the same (total) power / energy input

1

(d) potential difference increases

1

current decreases

1

(e) 1000 (Ω)

reason only scores if R = 1000 (Ω)

1

potential difference is shared in proportion to the resistance

allow a justification using a correct calculation

1

(f) $12 = I \times 7000$

1

$$I = \frac{12}{7000}$$

1

$I = 1.71 \times 10^{-3}$ (A)

*an answer that rounds to 1.7×10^{-3} (A) scores **3** marks*

1

$I = 1.7 \times 10^{-3}$ (A)

this answer only

or

I = 0.0017 (A)

*an answer of 2.4×10^{-3} (A) scores **2** marks*

*if no other marks scored allow **1** mark for calculation of total resistance (7000 Ω)*

1

*an answer of 1.7×10^{-3} (A) scores **4** marks*

[14]