Mark schemes

1.

(a) A: transmission / power cables

allow transmission / power lines

allow cables ignore wires

1

B: step-down transformer

1

(b) less thermal energy is transferred to the surroundings.

1

(c) charge flow = $\frac{500\ 000\ 000}{25\ 000}$

1

charge flow = 20 000 (C)

1

(d) total current = 7.20 (A)

1

P = 230 × 7.20

allow a correct substitution of an incorrect total current

1

P = 1656 (W)

allow a correct calculation using an incorrect total current

1

(e) dishwasher

1

has the largest current
or
has the largest power (input)

1

(f) E = 600 × 32 000 000

1

E = 19 200 000 000 (J)
or
E = 1.92 × 1010 (J)

1

[12]

2. (a) (fixed) solar cells aren't always pointed (directly) at the Sun

or

(fixed) solar cells don't track the Sun (through the sky)

1

(fixed) solar cells don't (always) receive maximum intensity of solar radiation

allow solar cells won't receive as much (solar) energy
allow solar cells won't generate as much electricity

1

(b) $Q = 3.5 \times 3600$

1

$Q = 12\,600$ (C)

1

(c)

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

1

(d)

$$0.16 = \frac{\text{useful power output}}{7500}$$

1

useful power output =
0.16×7500

1

useful power output = 1200 (W)

1

(e) the energy becomes less useful

1

(f) a very large area would need to be covered with solar cells

1

[10]

3. (a) uniform acceleration

allow constant / steady acceleration
allow velocity / speed increasing at a constant rate
ignore reference to direction
*acceleration scores **1** mark*
or
*velocity / speed is increasing scores **1** mark*
*do **not** accept acceleration increases*

2

(b) up(wards)

1

(c) a group of objects that interact

1

(d) velocity just after bounce is less than just before bounce

allow velocity is less / decreases
velocity decreases to zero – on its own scores zero

or

the height at the top of the bounce is less than the height from which it was dropped

1

so the ball has lost energy

1

correct reference to (loss of) ke or (reduced) gpe

1

total energy of ball and Earth / ground is constant

allow 'a system' for ball and Earth
allow energy is conserved

1

[8]

4. (a) higher

1

(b) low(er)

1

hot(ter)

allow warm(er)

1

(c) advantage:

- water heated continuously (by the Sun)

1

one disadvantage from:

- temperature of water is lower (for most of the time than water heated by immersion heater)
- water may not be hot enough

allow less control over water temperature

- it takes longer to heat the water

1

(d) $\frac{4\,030\,000}{4\,070\,000}$

1

0.99

*an answer of 99% scores **2** marks*
*an answer of 99 or 0.99% scores **1** mark*

1

*an answer of 0.99 scores **2** marks*
*allow an answer that rounds to 0.99 for **2** marks*

(e) power = energy transferred / time
allow P = E / t

1

(f) $5000 = \frac{4\,070\,000}{t}$

1

$t = \frac{4\,070\,000}{5000}$

1

$t = 814$

1

seconds

other units of time must be consistent with numerical value

1

*an answer of 814 seconds scores **4** marks*
*an answer of 13.57 minutes scores **4** marks*

[12]

5. (a) gravitational potential
this order only

1

kinetic

1

(b) kinetic energy = 0.5 × mass × speed2

or

Ek = ½mv2

1

(c) $5040 = 0.5 \times m \times 122$ **1**

$$m = \frac{5040}{0.5 \times 12^2}$$ **1**

$m = 70$ (kg) **1**

(d) the thermal energy increases. **1**

[7]

6. (a) the polarity (of the supply) does not change **1**
allow potential difference in one direction (only)

(b) energy transferred = power × time **1**

(c) $162\,000\,000 = 7200 \times t$ **1**

$$t = \frac{162\,000\,000}{7200}$$ **1**

$t = 22\,500$ (s) **1**

(d) $V = I \times R$ **1**

(e) $480 = 15 \times R$ **1**

$$R = \frac{480}{15}$$ **1**

$R = 32$ (Ω) **1**

(f) time taken using system **A** is double the time of system **B** **1**

[10]

7. (a) nuclei **1**
do not accept atoms

decreases **1**

(b) m = 0.004 (kg)

1

E = 0.004 × 5200 × 50 000 000

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

1

E = 1.04 × 109 (J)
or
E = 1 040 000 000 (J)

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

1

(c) any **two** from:

- to make sure the fusion process is possible
  to develop an understanding of the process
- to make adaptations to the process to assess the efficiency of the process to
- make predictions
- assess safety risks
- to assess environmental impact
- set-up cost is lower (for small scale experiments)
-

2

(d) releases carbon dioxide

allow releases greenhouse gases

1

which causes global warming

allow which causes climate change

OR

releases particulates
which causes global dimming
or
which cause breathing problems

OR

releases sulfur dioxide
which cause acid rain

OR

releases nitrogen oxides
which cause breathing problems
or
which causes acid rain

1

[9]

8. (a) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

Factors

- poor condition of tyres
- poor road surface
- wet or icy road
- poor/worn brakes

Explanation

- because of decreased friction

Factors

- increased mass of car/passengers

Explanation

- increases kinetic energy of car
- more work needs to be done to stop car
- increases momentum of the car

Factor

- road slopes downhill

Explanation

- (a component of) gravity opposes the braking force
  resultant (braking) force is reduced
-

allow answers in terms of reducing braking distance throughout

A single factor with no related explanation is insufficient to score a mark

(b) resultant force = mass × acceleration

1

(c) $7200 = 1600 \times a$

ignore negatives throughout

1

$a = \frac{7200}{1600}$

1

$a = 4.5$ (m/s2)

1

(d) 15 (m) 38 (m)

two correct values identified

1

= 53 (m)

allow the correct addition of a misread braking distance and /or a misread thinking distance taken from the graph

1

(e) $p = \frac{F}{A}$

1

(f) $120\,000 = \frac{60}{A}$

1

$A = \frac{60}{120\,000}$

1

$A = 0.0005$

1

$A = 5\ (.0) \times 10{-}4$

allow an answer given to 2 sig figs from an incorrect calculation using the given data

1

m^2

1

[16]

9. (a) the friction is decreased

1

(b) Ep = 62.5 × 9.8 × 16.0

1

E p = 9800 (J)

1

(c) Ek = 0.5 × 62.5 × 122

1

Ek = 4500 (J)

1

(d) Any **two** from:

- speed (at bottom of slide)
- friction *(*between sled and ground*)*

  allow mass/weight of rider (and sled)

  allow surface type
- air resistance

2

[7]

10. (a) density = $\frac{\text{mass}}{\text{volume}}$

or

$\rho = \frac{m}{V}$

1

(b) $998 = \frac{\text{m}}{6\ 500\ 000}$

1

$m = 998 \times 6\ 500\ 000$

1

$m = 6\ 487\ 000\ 000$

1

$m = 6.487 \times 109$ (kg)

allow a correct conversion of their calculated value of mass into standard form

1

(c) energy transferred = power × time

or

EPt

1

(d) $t = 18\ 000$ (s)

or

$t = 5 \times 60 \times 60$

1

$E = 1.5 \times 109 \times 18\ 000$

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

1

$E = 2.7 \times 1013$ (J)

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

1

(e) the variation in demand is (much) greater than 1.5 × 109 W

allow the increase in demand is greater than the (power) output of the (hydroelectric) power station

1

demand remains high for longer than 5 hours

allow 04:00 to 16:00 is 12 hours

allow 04:00 to 16:00 is greater than 5 hours

1

[11]

11. (a) K = step-up transformer

1

L = transmission cables

allow power cables

ignore wires

1

M = step-down transformer

allow 1 mark if K and M are labelled transformer but step-up and step-down labels are incorrect or not present

1

(b) 8 (%) and 32 (%)

both required

1

Number of times = 4

1

(c) (burning gas) releases carbon dioxide

1

which causes global warming

*allow greenhouse effect **or** climate change*

1

(d) An energy resource that can be replenished quickly.

1

(e) higher power output

allow more electricity generated

1

lower variation in power output

1

[10]

12. (a) kg

allow kilogram

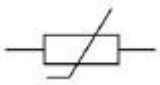
1

°C

allow degrees Celsius

1

(b)



1

(c) P = 122 × 15

1

P = 2160 (W)

1

(d) The heating element in the kettle takes time to heat up

1

(e) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced 3–4

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content:

- measure the mass of water using a balance
  or
  measure the volume of water using a measuring cylinder
- measure the initial temperature of the water
- pour the water into the kettle
- put temperature probe in the water
  or
  put a thermometer in the water
- switch kettle on
- record temperature
- measure time with a stopclock
- use an interval of 5 seconds

(f) $\Delta\Theta = 80$ (°C)

1

E = 0.50 × 4200 × 80

allow E = 0.50 × 4200 × their value of ΔΘ

1

E = 168 000 (J)

allow an answer consistent with their value of ΔΘ

1

(g) m = 0.005 (kg)

1

E = 0.005 × 2 260 000

this mark may score if m is not/incorrectly converted

1

E = 11 300 (J)

allow an answer consistent with their value of m

1

[18]

13. (a) use a tape measure

allow use a metre rule

allow use a laser measure

1

one person holding the top and another person holding the bottom
or
use a set square to ensure tape measure is vertical

allow use a plumb-line to ensure tape measure is vertical

or
take repeat readings and calculate a mean

1

(b) Ep = 45 × 9.8 × 2.0

an answer of 880 (J) or 882 (J) scores 2 marks

1

Ep = 880 (J)

1

(c) any **3** from:

- change in vertical height
- mass / weight
- speed / velocity
- air resistance or drag

allow body position

allow wind

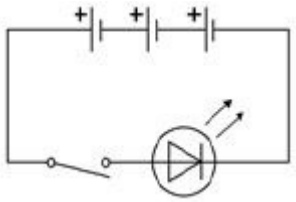
- friction (between zip line and pulley)
- gradient / angle (of the zip wire)
- length of zip wire

ignore gravitational field strength

3

[7]

14. (a)



1

(b) charge flow = current × time

or

$Q = It$

1

(c) I = 0.050 (A)

1

Q = 0.050 × 14 400

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

1

Q = 720 (C)

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

1

(d) there is no current in a diode (in the reverse direction)

or

charge will not flow through a diode (in the reverse direction)

allow diode will not conduct (electric charge)

do not accept the circuit is not complete

1

(because) a diode has a (very) high resistance (in the reverse direction)

1

(e) Efficiency = $\frac{\text{Useful power output}}{\text{Total power input}}$

1

(f) $0.75 = \frac{\text{Useful power output}}{0.24}$

1

Useful power output = 0.75 × 0.24

1

Useful power output = 0.18 (W)

1

[11]

15. (a) carbon dioxide released

greenhouse gases is insufficient carbon emissions is insufficient allow CO2

1

causing global warming

allow climate change

allow named consequence of global warming

allow greenhouse effect

air pollution is insufficient

OR

particulates released (1)

causing global dimming (1)

OR

sulfur dioxide released (1)

allow SO2

causing acid rain (1)

1

(b) any **2** from:

*do **not** accept solar*

- wind
- tidal
- wave
- hydroelectric

allow pumped storage

hydro is insufficient

- geothermal
- biofuel

allow biomass or named biofuel, eg wood

2

(c)

*an answer of 22 (%) scores **2** marks*

100 – 78

*allow **1** mark for calculating percentage of named resources (78%)*

1

22 (%)

1

(d)

*an answer of 12 500 (MW) scores **2** marks*

maximum demand = 37 500 (MW)
and
minimum demand = 25 000 (MW)

1

difference in demand = 12 500 (MW)

1

(e) solar panels generate electricity from light
solar panels make energy is insufficient

1

power output would increase throughout the morning
or
power output would increase (between 06:00 and 09:00)
or
(between 06:00 and 09:00) the Sun is rising / shining

1

[10]

16. (a) (the diesel car has a) higher range
allow less frequent refuelling needed

1

(the diesel car) power source has a lower mass
allow the power source has a lower weight
the diesel car has a lower mass is insufficient

1

(b)

*a correct answer that rounds to 26 (%) scores **2** marks*

$$\% \text{ of total mass} = \frac{420}{1610} (\times 100)$$

*allow **1** mark for an answer of 0.26*

1

% of total mass = 26 (%)

1

(c) any **2** from:

- increase the range of electric cars
- increase the time between recharges
- decrease the (total) mass of the electric car
- greater acceleration

2

(d) energy transferred = power × time
or
E = *Pt*

1

(e)

*an answer of 60 (s) scores **3** marks*

420 000 = 7000 × t

1

t = 420 000 / 7000

1

t = 60 (s)

1

[10]

17. (a) To reduce energy transfer to the surroundings

1

(b) scald / burn (to skin)
ignore risk of electric shock

1

(c) 1 °C

1

(d) 0.06 kg

1

(e)

*a numerical answer of 4400 scores **3** marks*

$26\,400 = 0.20 \times c \times 30$

1

$$c = \frac{26\,400}{(0.20 \times 30)}$$

or

$$c = \frac{26\,400}{6}$$

1

$c = 4400$

1

J / kg °C

1

[8]

18. (a) The energy transferred each second to the bulb.

1

(b) power = potential difference × current

or

$P = VI$

1

(c)

*an answer of 0.17 (A) scores **3** marks*

$40 = I \times 230$

1

$$I = \frac{40}{230}$$

1

I = 0.17 (A)

*a correct answer that rounds to 0.17 (A) scores **3** marks*

1

(d)

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

1

(e)

*an answer of 2.7 (W) scores **3** marks*

$$0.30 = \frac{\text{useful power output}}{9.0}$$

1

useful power output = 0.30 × 9.0

1

useful power output = 2.7 (W)

1

(f) bulbs also transfer thermal energy

allow light bulbs emit infrared radiation as well as visible light

ignore so people know how bright the bulb is

1

the efficiency of the light bulb also needs to be considered

allow the cost to power the light bulb depends on the efficiency

allow to see how much energy is wasted

1

[11]

19. (a)

*an answer of 0.50 scores **3** marks*

*allow a correct answer that rounds to 0.50 for **3** marks*

$$41 = \frac{9.8 \times h}{0.12}$$

1

$$h = \frac{41 \times 0.12}{9.8}$$

1

h = 0.50 (m)

1

(b) kinetic energy = 0.5 × mass × (speed)2

or

Ek = ½mv2

1

(c)

*an answer of 60 (kg) scores **3** marks*

$270 = ½ \times m \times 32$

1

$m = \frac{270}{(½ \times 3^2)}$

or

$m = \frac{270}{4.5}$

1

m = 60 (kg)

1

(d) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear.

3–4

Level 1: Relevant features are identified and differences noted.

1–2

No relevant content

0

Indicative content

- males have a greater muscle power than females for most of their lives • males have a greater muscle power than females above 9/10 years old • males have a lower muscle power than females below 9/10 years old
- there is a similar pattern for males and females as age increases
- males have a peak muscle power at 25 years old whereas females have a peak muscle power at 20/21 years old
- at 9/10 years old males have the same muscle power as females
- peak muscle power for males (47 W/kg) is greater than peak muscle power for females (37 W/kg)
- the rate of increase of muscle power is greater for males than females (between 5 and 25 years old)
- the rate of decrease of muscle power is greater for males than females.

Ignore comments relating to strength

(e) any **1** from:

- maximum height reached is a better indicator of maximum muscle power
  allow maximum time in the air for maximum height reached / jumped
- maximum / peak muscle power was being investigated, not mean / average muscle power
- volunteer may not use maximum effort on the first try
- performance may improve with practice
- performance may get worse with tiredness

1

[12]

20. (a) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- Wrap N layers of newspaper around the metal can
- Heated water in a kettle
  or
  Using a Bunsen burner

• Put hot water in the metal can • Use a measuring cylinder to measure the volume of water • Measure initial and final temperature with the digital thermometer • Use a stopclock / stopwatch to measure a time of 5 minutes • Calculate temperature decrease • Repeat with different number of layers of newspaper • Repeat with no layers of newspaper • Use same initial temperature of hot water • Use same volume of water each time

Level 3: Workable method which includes changing the number of layers and includes at least one control variable (same volume of water or same starting temperature)

(b) the digital thermometer and the datalogger have the same resolution

allow both measure to 1 d.p. ignore accuracy ignore precision

they give the same result is insufficient

1

only need to measure the start and end temperature
or
only need 2 readings
or
only need to calculate the temperature change

1

[8]

21. (a) chemical

1

kinetic

1

in this order only

(b) Ek = 0.5 × 80 × 122

1

Ek = 5760 (J)

1

*an answer of 5760 (J) scores **2** marks*

(c) E = 0.040 × 480 × 50

1

E = 960 (J)

1

*an answer of 960 (J) scores **2** marks*

(d) increased

1

[7]

22. (a) nucleus

1

neutron

1

gamma rays

1

in this order only

(b) $\frac{25\,000\,000}{2\,400\,000}$

1

11

*an answer of 10.4 with no working scores **1** mark*

1

*an answer of 11 scores **2** marks*

(c) any **two** from:

- waste is radioactive
  allow nuclear waste
- waste has a long half-life
  allow waste remains dangerous for a long time
- waste is toxic
- waste needs to be buried
  allow waste is difficult to dispose of
- risk of catastrophic accidents
  allow named accident e.g. Fukushima, Chernobyl, Three Mile Island
- fuel is non-renewable

2

(d) **similarity:**
(carbon dioxide concentration and global temperature have) both increased
allow they both show a positive correlation

1

difference:
the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off
allow carbon dioxide (concentration) increases more quickly than temperature (increase)

1

[9]

23. (a) $P = \frac{120\,000}{8.0}$

1

P = 15 000 (W)

1

*an answer of 15 000 (W) scores **2** marks*

(b) energy is transferred in heating the surroundings

1

friction causes energy to be transferred in non-useful ways

1

(c) the switches are in parallel

1

(so) closing either switch completes the circuit

1

(d) gravitational potential energy = mass × gravitational field strength × height
allow Ep = m g h

1

(e) Ep = 280 × 9.8 × 14

1

Ep = 38 416 (J)

1

Ep = 38 000 (J)

*an answer that rounds to 38 000 scores **2** marks*

1

*an answer of 38 000 scores **3** marks*

[10]

24. (a) power output increases (to meet demand) due to people returning home from work / school

accept many electrical appliances are switched on (which increases demand)

1

accept other sensible suggestions

(b) 00.00

accept midnight

1

allow answers between 00.00 and 04.00

(c) any **two** from:

- conserves fuel reserves
- spare capacity to compensate for unreliable renewable resources
- provides spare capacity in case of power station emergency shut-down
- so as to not make unnecessary environmental impact

2

[4]

25. (a) 0.1 (°C)

1

(b) power = energy transferred / time

allow P = E / t

1

allow E = P × t

(c) 1050 / 300

1

3.5 (W)

1

*accept 3.5 (W) with no working shown for **2** marks*

(d) 1050 = m × 4200 × 0.6

1

m = 1050 / (4200 × 0.6)

1

m = 0.417 (kg)

1

*accept 0.417 (kg) with no working shown for **3** marks*

(e) any **one** from:

- energy used to heat metal pan (as well as the water)
- energy transfer to the surroundings (through the insulation)
- angle of solar radiation will have changed during investigation
- intensity of solar radiation may have varied during investigation

1

[8]