GCSE
PHYSICS
AQA - COMBINED SCIENCE
MARK SCHEME

P1
ENERGY
TEST 3
Mark schemes

(a) \( E_p = 50 \times 9.8 \times 4.0 \)

\[ E_p = 1960 \text{ (J)} \]

*allow an answer rounded to 2000 (J)*

*allow a maximum of 1 mark if \( g = 10 \text{ N/kg} \) is used*

*an answer of 1960 scores 2 marks*

(b) \( E_k = 0.5 \times 50 \times 7^2 \)

\[ E_k = 1225 \text{ (J)} \]

*allow 1200 or 1230 (J)*

*an answer of 1225 scores 2 marks*

(c) some energy is wasted

the g.p.e of the girl is not zero

(d) reduces the amount of friction

*do not accept reference to friction between the wheels and the ramp*

so more energy is usefully transferred

*allow less energy is wasted or less heating*

greater kinetic energy

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(a) biofuel

geothermal

(b) it is predictable

(c) 2.8 MW
(d) any two from:
• visual pollution
• noise pollution
• dangerous to birds
• may lower house prices

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

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

No relevant content

Indicative content
• less fossil fuel burnt
• more nuclear fuel used
• more renewables used
• gas remained the same
• less carbon dioxide released
• less greenhouse gases
• less global warming
• less acid rain
• less environmental pollution
• more hazardous waste produced (nuclear)
• the percentage generated by coal has decreased 8%
• the percentage generated by renewables has increased by 6%
• the percentage generated by nuclear has increased by 2%

(a) add thermal insulation to the roof
replace the single-glazed windows with double-glazed windows

(b) 110

(c) the time taken increases

(d) advantage of solar panel:
cheap(er) to run / use (1)
ignore cheap / free unqualified
(as) no energy / fuel cost (1)
or

no carbon dioxide emissions (1)

*allow no greenhouse gases emitted*

(so) does not contribute to global warming or climate change (1)

*allow description of effect of global warming*

or

renewable (1)

(as) sunlight is replenished (1)

or

conserves nuclear / fossil fuels (1)

(as) sunlight is renewable (1)

or

does not burn fossil fuels (1)

(so) no carbon dioxide emissions (1)

*allow no greenhouse gases emitted*

Max 2 marks

disadvantage of solar panel:

unreliable (1)

*allow water not always hot enough*

*allow it may not (always) work*

(as sun)light not available (1)

*allow not always sunny*

*allow as it might be cloudy / dark*

*ignore weather*

*ignore night unqualified*

*ignore no sun*

or

expensive (1)

due to high cost of manufacturing / installing solar panels (1)

Max 2 marks

(a) thermometer
stopclock / stopwatch
accept measuring cylinder
accept top pan balance

(b) independent: type of oil

dependent: temperature rise in °C

(c) wear safety goggles

oil not heated directly

accept any reasonable comment about not handling hot apparatus.

(d) repeat the experiment

and calculate the mean temperature rise

OR

heat the oil for a longer period of time (1)
to get a wider range of temperatures (1)

(e) \( \frac{17 + 17 + 18}{3} = 17.33 \)

temperature rise = 17 (°C)

accept 17 (°C) with no working shown for 2 marks
allow 17.33 with no working shown for 1 mark

(f) \[ E = 0.025 \times 1800 \times 20 \ (J) \]

\[ E = 900 \ (J) \]

allow 900 without working shown for the 2 calculation marks

Joule
(a) \[ 80 \, ^{\circ}\text{C} \]
\[ \Delta E = 0.5 \times 3400 \times 80 \]
\[ \Delta E = 136\,000 \, (J) \]
*an answer of 136\,000 \, (J) scores 3 marks*

(b) energy is dissipated into the surroundings
*allow any correct description of wasted energy*

(c) put a lid on the pan
*allow any sensible practical suggestion*
*eg add salt to the water*

(d) efficiency = \( \frac{300}{500} \)

\[ \text{efficiency} = 0.6 \]
*an answer of 0.6 or 60\% scores 2 marks*
*allow efficiency = 60\%*
*an answer of 0.6 with a unit scores 1 mark*
*an answer of 60 without a unit scores 1 mark*

(e) lower rate of energy transfer

(so) potato soup will remain at a higher temperature

(a) the store of chemical energy (in the battery) decreases

the internal energy of the surrounding air increases.

*accept description of energy becoming less usefully stored for 2 marks*

(b) kinetic energy = \( \frac{1}{2} \, \text{mass} \times \text{velocity}^2 \)

(c) \[ E_K = \frac{1}{2} \times 0.8 \times 12^2 \]

\[ E_K = 57.6 \, (J) \]
allow 57.6 (J) without working shown for 2 marks

(d) lower proportion of wasted energy
   accept less energy is wasted

higher proportion of energy is converted into kinetic energy
   accept more kinetic energy

(e) Level 2 (3–4 marks):
A relevant and coherent argument which demonstrates processing and numerical analysis of the information presented and draw a conclusion which is logically consistent with the reasoning and refers to payback time for the vehicles.

Level 1 (1–2 marks):
Simple comparisons are made which demonstrate a basic ability to numerically analyse the information presented. The conclusion, if present, may not be consistent with the calculations.

0 marks:
No relevant content

Indicative content
- The electric car costs £12 000 more to buy
- Running cost of electric car = £3 000
- Running cost of petrol engine car = £24 000
- Total cost of electric car = £30 000
- Total cost of petrol engine car = £39 000
- The electric car cost £1 750 less to run each year
- The electric car will save £9 000
- Additional cost is covered in 6.9 years
- So the electric car will be cheaper over the 12 year lifetime

or

Electric
27000 / 12 = 2250
Annual cost = 2250 + 250 = 2500

Petrol
15000 / 12 = 1250
Annual cost = 1250 + 2000 = 3250

So electric is £750 cheaper per year

4

(a) kinetic energy = 0.5 × mass × (speed)²
   allow \( E = \frac{1}{2}mv^2 \)
(b) \( 0.5 \times 9000 \times 30^2 \) 

4 050 000

4050 (kJ)

*an answer of 4050 (kJ) scores 3 marks*
*an answer of 4 050 000 scores 2 marks*

(c) **efficiency** = 

\[
\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}
\]

(d) 

\[ 0.80 = \frac{\text{useful output energy transfer}}{4050} \]

*allow ecf from (b)*

(useful output energy transfer =) \( 0.80 \times 4 \, 050 \)

= 3240 (kJ)

*an answer of 3240 (kJ) scores 3 marks*
<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.</td>
<td>3-4</td>
</tr>
<tr>
<td>1</td>
<td>Relevant features are identified and differences noted.</td>
<td>1-2</td>
</tr>
<tr>
<td></td>
<td>No relevant content</td>
<td>0</td>
</tr>
</tbody>
</table>

**Indicative content**

**Advantages of both methods:**
- both renewable sources of energy
- both have no fuel (cost)
- no carbon dioxide produced

**Advantages of wind**
- higher average power output

**Advantages of hydroelectric**
- constant / reliable power (output)
- lower (installation) cost

**Disadvantages of wind**
- higher (installation) cost
- variable / unreliable power output

**Disadvantages of hydroelectric**
- lower power output

**Disadvantages of both methods**
- (may be) noisy
- visual pollution

(a) *x*-axis labelled and suitable scale

points plotted correctly

- allow 5 correctly plotted for 2 marks, 3–4 correctly plotted for 1 mark
- allow ± ½ square

line of best fit

1 2 4
(b) \[
\frac{4.5}{60}
\]
allow ecf from line of best fit in part (a)

0.075 (°C/s)

an answer of 0.075 (°C/s) scores 2 marks

(c) \[\Delta \theta = 11.5 \, (^\circ \text{C})\]
a calculation using an incorrect temperature scores max 3 marks

\[\Delta E = 1.50 \times 900 \times 11.5\]
\[\Delta E = 15525 \, (\text{J})\]
\[\Delta E = 15525 \, (\text{kJ})\]

an answer of 15.525 (kJ) or 15.53 (kJ) or 15.5 (kJ) scores 4 marks

an answer of 15525 (kJ) scores 3 marks

(d) any two from:
- mass of block*
- size / dimensions of block*
- material of block*
  *allow same block for 1 mark
- current through heater
  allow power of heater
- thickness of insulation*
- material of insulation*
  *allow same insulation for 1 mark
- time interval
- starting temperature (of block / heater)

(a) very little cloud cover
  allow high intensity sunlight

favourable wind speed
  allow high wind speed
(b) \(35.4 \times 10^9\)

\[ E = 35.4 \times 10^9 \times (20.8 / 100) \]

\[ E = 7.4 \times 10^9 (J) \]

An answer of \(7.4 \times 10^9 (J)\) or \(7,400,000,000\) scores 3 marks

allow 7,400,000,000

1

(c) nuclear

1
<table>
<thead>
<tr>
<th>Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.</th>
<th>4-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear</td>
<td>3-4</td>
</tr>
<tr>
<td>Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.</td>
<td>1-2</td>
</tr>
<tr>
<td>No relevant content</td>
<td>0</td>
</tr>
</tbody>
</table>

**Indicative content**

**step up transformer**
- increases the potential difference
- decreases the current
- reduces heating of transmission cables
- less wasted energy
- more efficient energy transfer

**transmission cables**
- low resistance
- reduces heating
- reduces wasted energy

**step down transformer**
- increases the current
- decreases the potential difference
- to a safe level
- the level is suitable for domestic appliances
(e) \[ P = \frac{E}{t} \]

\[ P = \frac{18\,000\,000}{3\,600} \]

\[ P = 5\,000 \]

\[ P = \frac{I}{V} \]

\[ I = \frac{P}{V} \]

\[ I = \frac{5\,000}{230} \]

\[ I = 22 \text{ (A)} \]

allow an answer that rounds to 22 (A)

an answer of 22 (A) scores 5 marks

(a) the wall has two / three layers

allow the wall is thick

cavity wall insulation / brick / block has a low thermal conductivity

so less energy is transferred by conduction

allow rate of energy transfer is lower

ignore any reference to convection and / or radiation

(b) \[ T = 17.4 + \left( \frac{(20.8 - 17.4)}{2} \right) \]

or \[ T = 20.8 + \left( \frac{(20.8 - 17.4)}{2} \right) \]

\[ T = 19.1 \text{ (°C)} \]

an answer in the range 18.5–19.1 scores 2 marks
(c) chemical energy store of the fuel decreases

thermal energy store of the water increases

\textit{allow kinetic energy store of the water particles increases}

thermal energy store of the air / atmosphere increases

\textit{allow kinetic energy store of the air particles increases}

(d) \( E = 15 \, 000 \, 000 \) (J)

\( t = 600 \) (s)

\( P = \frac{15 \, 000 \, 000}{600} \) (W)

\textit{allow a correct substitution of incorrectly / not converted values of }E\textit{ and / or }t

\textit{allow a correct calculation using incorrectly / not converted values of }E\textit{ and / or }t

[12]