AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.3.2.2 TEMPERATURE CHANGES IN A SYSTEM AND SPECIFIC HEAT CAPACITY (PACK 1)

SCORE	PERCENTAGE
/184	%

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Q1.

(a) 78 (°C)

*allow **2** marks for correct temperature change ie 22 °C*
*allow **1** mark for correct substitution*
ie 46 200 = 0.5 × 4200 x θ
or

$$\frac{46200}{0.5 \times 4200} = \theta$$

3

(b) 6.4 (W)

*allow **2** marks for an answer that rounds to 6.4*
*allow **1** mark for correct substitution*
ie 46 200 = P × 7200
an answer of 23 000 or 23 100 or 385 gains 1 mark

2

[5]

Q2.

(a) (i) any **two** from:

- mass (of block)
  accept weight for mass
- starting temperature
- final / increase in temperature
  temperature is insufficient
- voltage / p.d.
  same power supply insufficient
- power (supplied to each block)
- type / thickness of insulation
  same insulation insufficient

2

(ii) one of variables is categoric
or
(type of) material is categoric
accept the data is categoric
accept a description of categoric
*do **not** accept temp rise is categoric*

1

(iii) concrete
reason only scores if concrete chosen

1

(heater on for) longest / longer time
a long time or quoting a time is insufficient
*do **not** accept it is the highest bar*

1

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(iv) 4500 (J)

*allow **1** mark for correct substitution ie*

2 × 450 × 5 provided no subsequent step shown

2

(b) (i) point at 10 minutes identified

1

(ii) line through all points except anomalous

line must go from at least first to last point

1

(iii) 20 (°C)

if 20°C is given, award the mark.

If an answer other than 20°C is given, look at the graph. If the graph shows a correct extrapolation of the candidate's best-fit line and the intercept value has been correctly stated, allow 1 mark.

1

(iv) 2 (minutes)

1

[11]

Q3.

(a) conduction

1

(b) 35 000

1

(c) 500

*their (b) = 2 x c x 35 correctly calculated scores **2** marks*

*allow **1** mark for correct substitution,*

ie 35000 = 2 x c x 35

or

their (b) = 2 x c x 35

2

J / kg°C

1

(d) energy lost to surroundings

or

energy needed to warm heater

accept there is no insulation (on the copper block)

*do **not** accept answers in terms of human error or poor results or defective equipment*

1

[6]

Q4.

(a) (i) 70

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accept ± half a square
(69.8 to 70.2)

1

(ii) 15

*accept 14.6 to 15.4 for **2** marks*
*allow for **1** mark 70 − 55*
ecf from (b)(i) ± half a square

2

(iii) C

1

biggest drop in temperature during a given time
accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature
accept same temperature as surroundings

1

(b) (i) 6720

*correct answer with or without working gains **3** marks*
*6 720 000 gains **2** marks*
*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*
*correct substitution of E = 200 × 4200 × 8 gains **1** mark*

3

(ii) the fastest particles have enough energy
accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases
accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)
accept speed for energy

1

[14]

Q5.

(a) (i) temperature (increase) and time switched on are directly proportional

accept the idea of equal increases in time giving equal increases in temperature
answers such as:

- *as time increases, temperature increases*

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- *positive correlation*
- *linear relationship*
- *temperature and time are proportional*

*score **1** mark*

2

(ii) any **one** from:

"it" refers to the metal block

- energy transfer (from the block) to the surroundings

accept lost for transfer
accept air for surroundings

- (some) energy used to warm the heater / thermometer (itself)

accept takes time for heater to warm up

- (metal) block is not insulated

1

(iii) 15 000

*allow **1** mark for correct substitution, ie 50 × 300 provided no subsequent step shown*

2

(b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

accept needs less energy to heat it (by the same amount)
lowest specific heat capacity is insufficient

1

[7]

Q6.

(a) (i) hot water rises (not heat)

for 1 mark

due to convection currents
or water expands/becomes less dense on heating
or less dense water rises

any for 1 mark

2

(ii) inside hotter (than outside)

for 1 mark

1

(iii) (heat transfer by) conduction

for 1 mark

1

(iv) surround/cover/insulate tank with poor conductor **or** named insulator

for 1 mark each

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2

(b) (i) air is an insulator/poor conductor

for 1 mark

1

(ii) convection stopped foam is an insulator/poor conductor

for 1 mark each

2

[9]

Q7.

(a) conduction

1

(b) (i) there is a bigger temperature difference between the water and the surrounding air

accept the water is hottest / hotter

1

so the transfer of energy (from hot water) is faster

accept heat for energy

ignore temperature falls the fastest

1

(ii) 120

*allow **1** mark for converting kJ to J correctly, ie 4 032 000*

or

correctly calculating temperature fall as 8°C

or

allow **2** marks for correct substitution, ie 4 032 000 = m × 4200 × 8

answers of 0.12, 19.2 **or** 16.6 gain **2** marks

answers of 0.019 **or** 0.017 gain **1** mark

3

(iii) water stays hot for longer

1

so heater is on for less time

accept so less energy needed to heat water

1

so cost of the jacket is soon recovered from) lower energy costs / bills

accept short payback time

1

[9]

Q8.

(a) to reflect (the infrared)

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accept (shiny surfaces) are good reflectors
ignore reference to incorrect type of wave

1

(b) black

1

best absorber (of infrared)

answer should be comparative
black absorbs (infrared) is insufficient
accept good absorber (of infrared)
ignore reference to emitter
ignore attracts heat
ignore reference to conduction

1

(c) to reduce energy loss

accept to stop energy loss
accept heat for energy
accept to stop / reduce convection

or
so temperature of water increases faster

accept to heat water faster
accept cooks food faster

or
reduces loss of water (by evaporation)

1

(d) 672 000

*allow **1** mark for correct substitution, ie 2 × 4200 × 80*
provided no subsequent step shown

2

[6]

Q9.

(a) (i) 5(.0)

1

(ii) 35 **or** their (a)(i) × 7 correctly calculated

*allow **1** mark for correct substitution, ie 5 **or** their (a)(i) × 7*
provided no subsequent step shown

2

(iii) 525(p)
or
(£) 5.25
or
their (a)(ii) × 15 correctly calculated

if unit p or £ given they must be consistent with the numerical answer

1

(iv) decreases

1

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temperature difference (between inside and outside) decreases

accept gradient (of line) decreases

*do **not** accept temperature (inside) decreases*

*do **not** accept graph goes down*

1

(b) air (bubbles are) trapped (in the foam)

*do **not** accept air traps heat*
foam has air pockets is insufficient

1

(and so the) air cannot circulate / move / form convection current

air is a good insulator is insufficient
no convection current is insufficient

answers in terms of warm air from the room being trapped are incorrect and score no marks

1

[8]

Q10.

(a) (matt) black is a good <u>emitter</u> of infrared / radiation

accept heat for infrared / radiation
ignore reference to good absorber
attracts heat negates this marking point

1

to give maximum (rate of) energy transfer (to surroundings)

accept temperature (of coolant) falls fast(er)

*accept black emits more radiation for **1** mark*

*black emits most radiation / black is the best emitter of radiation for **2** marks*

1

(b) the fins increase the surface area

accept heat for energy

1

so increasing the (rate of) energy transfer
or
so more fins greater (rate of) energy transfer

1

(c) 114 000

*allow **1** mark for correct temperature change, ie 15 (°C)*

or

*allow **2** marks for correct substitution, ie 2 × 3 800 × 15*

*answers of 851 200 **or** 737 200 gain **2** marks*

or

*substitution 2 × 3800 × 112 **or** 2 × 3800 × 97 gains **1** mark*

*an answer of 114 kJ gains **3** marks*

3

(d) increases the efficiency

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1

less (input) energy is wasted

accept some of the energy that would have been wasted is (usefully) used

or

more (input) energy is usefully used

accept heat for energy

1

[9]

Q11.

(a) (i) conduction

1

(ii) atoms gain (kinetic) energy

accept particles / molecules for atoms

*do **not** accept electrons for atoms*

or

atoms vibrate with a bigger amplitude

accept vibrate faster / more

*do **not** accept start to vibrate*

or

atoms collide with neighbouring atoms

1

transferring energy to (neighbouring / other) atoms

*do **not** accept heat for energy*

or

making these other atoms vibrate with a bigger amplitude

accept faster / more for bigger amplitude

mention of (free) electrons moving and passing on energy negates this mark

1

(b) (i) 5 (°C) to 25 (°C)

either order

1

(ii) a correct example of doubling temperature difference doubling heat transfer

eg going from 5 to 10 (°C) difference doubles heat transfer from 30 to 60 (J/s)

accept for heat transfer number of joules / it

*allow **1** mark for correctly reading 1 set of data eg at 5 °C the heat transfer is 30*

or

for every 5°C increase in temperature difference heat transfer increases by 30 (J/s)

no credit for stating they are directly proportional

2

(iii) 1800

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*allow **1** mark for obtaining heat transfer value = 120*

2

(c) payback time calculated as 33 years

calculations must be correct to score the first mark point

explanations must relate to it not being cost effective

1

this is greater than lifetime of windows
or
total savings (over 30 years) = £4800 (1)

this is less than cost of windows (1)
or
$\frac{5280}{30}$ = 176 (1)

this is more than the yearly savings (1)

1

[10]

Q12.

(a) (i) conduction

1

convection

1

correct order only

(ii) to keep the ceramic bricks hot for a longer time

1

(b) (i) $E = P \times t$

18.2

*allow **1** mark for correct substitution ie 2.6 × 7 provided that no subsequent step is shown*

2

(ii) 91 (p)
or their (b)(i) × 5 correctly calculated

accept £0.91

*do **not** accept 0.91 without £ sign*

1

(c) $E = m \times c \times \theta$

2 250 000

*allow **1** mark for correct substitution ie 120 × 750 × 25 provided that no subsequent step is shown*

answers 2250 kJ or 2.25 MJ gain both marks

2

[8]

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Q13.

(a) (i) walls

accept sides (of house)

1

(ii) fit double glazing
or
close / fit curtains / fit shutters

accept close windows

accept keep house at a lower temperature

accept fit (foam) draft excluders around the windows / in the jams

accept put plastic (film) across the windows

*do **not** accept fit thicker glass*

1

(b) (i) cavity (wall insulation)

accept the middle one

1

(ii) fit hot water jacket **and** draught-proofing

both required

1

(together) saves most money

only scores if first mark scores

accept saves more than fitting (energy efficient) light bulbs

accept saves £40

accept gives the shortest payback time

*an answer fit energy efficient light bulbs (on its own) gains **1** mark only*

1

[5]

Q14.

(a) (i) 2(.0)

accept 2000 W or 2000 watt(s)

accept answer given in table

*do **not** accept 2000*

1

(ii) 4.5

*allow **1** mark for correct substitution*

ie 1.5 × 3

*allow **1** mark for the answers 1.5 or 6(.0)*

2

(iii) 54
or
their (a)(ii) × 12 correctly calculated

*allow **1** mark for correct substitution*

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ie 4.5 × 12
or
their (a)(ii) × 12
*allow **1** mark if correct answer is given in pounds eg £54*

2

(b) (i) 6 pm

1

temperature starts to rise faster
only scores if 6 pm given

or
graph (line) is steeper / steepest
it refers to graph gradient or temperature
accept answers in terms of relative temperature rise
eg 5 to 6 pm 2 °C rise, 6 to 7 pm 6 °C rise
accept temperature rises sharply / rapidly / quickly
*do **not** accept temperature starts to rise*

1

(ii) middle box ticked

1

[8]

Q15.

(a) (i) £190
nb mention idea of cost per J in £ will come to an approx figure full credit given
*allow **1** mark for showing that the energy loss through the roof is ¼ of the total energy loss ie 150 / 600*

2

(ii) £142.50
allow ecf 50 % of their (a)(i) × 1.5 ie their (a)(i) × 0.75

1

(b) transferred to surroundings / atmosphere

or becomes spread out

1

[4]

Q16.

(a) loft insulation

1

energy saved in 10 years £600

1

net saving (600 – 110) £490

1

OR

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hot water jacket

1

energy saved in 10 years £140

1

This is the highest percentage saving on cost

1

(b) transferred to environment / surroundings

1

as heat / thermal energy

1

[5]

Q17.

(a) (i) convection current correctly shown
with arrows extending to above
insulation label line

circulation must show water rising in the left half of the tank
*accept continuous **or** broken arrows **must** be at least **one** arrow up and **one** arrow down*
*allow **1** mark for correct diagram which does not extend high enough*

2

(ii) it expands or it gets less dense

*do **not** allow hot water rises*
*do **not** accept explanation in terms of molecules expanding **or** changing density*
*do **not** accept lighter **or** heavier*

1

more dense water falls

allow cold water falls if qualified with a suitable reason

1

(b) (i) reflects heat back into the room **or** where it came from

accept infrared or radiation or energy for heat
accept bounce for reflect if in correct context

1

(ii) air is a (good) insulator or poor conductor **or** air stops conduction

*do **not** accept plastic foam is a good insulator **or** bad conductor*

1

air is trapped

1

convection loss reduced or stopped

1

(c) **two** out of the following three:

any answer which gains credit must contain a comparison

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rate of evaporation decreases

*accept less sweat can evaporate **or** evaporation is more difficult*

less heat energy removed from the body

higher *humidity* the less water vapour can be absorbed (into the air)

accept sweat for water vapour

*do **not** credit description of high humidity*

accept a correct answer in terms of dynamic equilibrium

2

[10]

Q18.

(a) four calculations correctly shown

200 × 10 – 1800 = £200
100 × 10 – 2400 = –£1400
50 × 10 – 600 = –£100
20 × 10 – 75 = 125

*accept four final answers only **or** obvious rejection of solar water heater and underfloor heating, with other two calculations completed any 1 complete calculation correctly shown **or** showing each saving × 10 of all four calculations = 1 mark answers in terms of savings as a percentage of installation cost **may** score savings mark only*

2

hot water boiler

correct answers only

1

(b) less electricity / energy to be generated / needed from power stations

accept less demand

1

reduction in (fossil) fuels being burnt

accept correctly named fuel

accept answer in terms of:
fewer light bulbs required because they last longer (1 mark)
less energy used / fuels burnt in production / transport etc. (1 mark)

ignore reference to CO_2 or global warming

ignore reference to conservation of energy

1

[5]

Q19.

(a) (i) (insulate it) with **fibre** glass **or** foam **or** felt **or** polystyrene beads **or** rockwool **or** (aluminium) foil

an example must be included

do not credit loft insulation

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1

(ii) fill the cavity with fibre glass **or** foam **or** mineral wool **or** polystyrene **or** named liner inside wall **or** making walls thicker

an example must be included

do not credit cavity wall insulation

1

(iii) double glaze **or** draw the curtains **or** blinds **or** thicker glass **or** secondary glazing described

do not credit fit smaller windows

1

(iv) put in draught excluder (or described) **or** strip **or** description of filling gaps **or** seal gaps **or** double glazed doors **or** build porch **or** curtains inside door **or** mat under door

do not credit just carpet

accept buy new doors
accept premise that gap is between frame and wall as well as between frame and door

1

(b) windy **or** stormy **or** wet **or** snow **or** rain **or** sleet **or** hail **or** fog **or** mist

do not credit frosty

1

[5]

Q20.

(a) (heat) is conducted through the glass

the answers must be within the context of the question

1

(heat) passes through glass and air by radiation

both glass and air required

1

(heat) crosses the air gap by convection

mention of conduction through air is neutral

1

(b) any **one** from

light

accept sunlight

gamma rays

X-rays

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radio

*accept sound **or** ir **or** microwaves **or** electromagnet waves*

1

(c) any **two** from

cuts down convection currents

accept stops air moving

air pockets trap air (from moving)

accept has air pockets
*do not accept stops heat moving **or** traps heat*

foam is a poor conductor

air in the foam is a good insulator

accept air is a good insulator in air pockets for both marks

2

(d) evaporation (of the water)

do not accept rain is cold

1

takes energy from the house

*accept takes heat away **or** higher energy molecules leave first*

1

[8]

Q21.

(a) insulation

allow example e.g fibreglass

1

double glazing

allow curtains

1

draught excluder

allow double glazing / close fitting door

allow turning down thermostat once only / turn down the heating

1

(b) transfers more useful energy

allow converts more energy into light / less into heat / less energy wasted

1

[4]

Q22.

(a) (i) £150

gets 2

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Else 1000 – (250 + 350 + 100 + 150) or 1000 – 850

gets 1

2

(ii) (Named) floor covering
OR Insulation under floor

for 1 mark

1

(b) (i) Draught proof doors or fibre glass in loft or in cavity
For draught proofing

gains 1 mark

Very low cost/easy to install
Repays for itself quickly/cost recuperated quickly
Reasonable energy saving

any 2 for 1 mark each

For loft insulation

Second lowest installation cost/easy to install
Reasonable large energy savings for this cost
Reasonable payback time

gains 1 mark

For foam filled cavity
Biggest energy/cash saving
Cost effective

any 2 for 1 mark each

3

(ii) **Double glazing**

gains 1 mark

Costs most
Saves least energy
Least cost effective

any 2 for 1 mark each

3

[9]

Q23.

(a) (i) 7pm

accept 19.00 / 1900

1

(ii) 8pm

accept 20.00 / 2000

1

temperature drops more slowly

accept heat for temperature accept line is less steep

1

(b) insulator

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1

conduction *

1

convection *

** answers can be either way around*

1

(c) (i) 4 (years)

1

(ii) it is the cheapest / cheaper / cheap

*do **not** accept answers in terms of heat rising or DIY*

1

has the shortest / shorter payback time

*do **not** accept short payback time*

1

[9]

Q24.

(a) air is (a good) insulator

1

or air is a poor conductor

accept air cavity / 'it' for air

reducing heat transfer by <u>conduction</u>

accept stops for reduces
ignore convection
*do **not** accept radiation*
*do **not** accept answers in terms of heat being trapped*

1

(b) (i) most cost effective

accept it is cheaper or low<u>est</u> cost
accept shortest payback time
accept in terms of reducing heat loss by the largest amount
*do **not** accept it is easier*
ignore most heat is lost through the roof

1

(ii) 4

1

[4]

Q25.

(a) (i) any **one** from:

water to the mug
water to the air
mug to the air
mug to the table

***both** required*

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direction of transfer must be correct

1

(ii) when <u>temperatures</u> are the same

accept a specific example eg when the <u>temperature</u> of the water and mug are the same

accept radiant heat transfer will never stop

1

(b) wood

1

(c) (i) conduction

accept convection if not given as 3rd answer

1

insulator

1

(ii) any **one** from:

*do **not** accept any rebuilding of house*

double glazing

loft insulation

accept roof for loft

1

carpets

(cavity) wall insulation

*do **not** accept closing doors and windows*

draft excluders

foil behind radiators

accept blocking chimney

paint inside walls white

[6]

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