AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.6.3 BLACK BODY RADIATION

SCORE	PERCENTAGE
/202	%

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Q1.

(a) any **one** from:

- too few turns / coils on the secondary

  allow number of turns / coils on the primary was increased

- p.d. across the primary was reduced

  ignore human error

1

(b) the p.d. (across the secondary) goes above 2V

allow p.d. across secondary is higher than p.d. across primary after 20 turns

1

(c) it increases (until the nails reach a constant temperature)

1

(d) $\frac{640}{4} = \frac{V_p}{1.75}$

1

$V_p = \frac{640 \times 1.75}{4}$

1

$V_p = 280$ (V)

1

$280 \times I_p = 336$

allow their calculated
$V_p \times I_p = 336$

1

$I_p = 1.2$ (A)

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

1

or

$336 = I_s \times 1.75$ (1)

$I_s = \frac{336}{1.75}$ (1)

$I_s = 192$ (A) (1)

$I_p = 192 \times \frac{4}{640}$ (1)

allow

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$$I_p = \text{their calculated } I_s \times \frac{4}{640}$$

I_p = 1.2 (A) (1)

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

*an answer of 1.2 (A) scores **5** marks*

[8]

Q2.

(a) point the first two fingers and thumb of the left hand so they are at right angles

1

point the first / index finger in the direction of the magnetic field from North to South

1

point the second / middle finger in the direction of current from positive to negative

allow in the direction of conventional current for positive to negative

1

the thumb then points in the direction of the force in this case to the left

1

(b) mean of 0.23 calculated

1

0.02

1

(c) $F = 0.40 \times 10^{-3} \times 9.8$

1

$F = 3.92 \times 10^{-3}$ (N)

1

$3.92 \times 10^{-3} = 0.03 \times 2.2 \times L$

*up to **3** marks to be awarded for a correct calculation of L using an incorrect value of F*

1

$$L = \frac{3.92 \times 10^{-3}}{0.03 \times 2.2}$$

1

L = 0.059 (m)

*an answer of 0.059 (m) scores **5** marks*

1

[10]

Q3.

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(a) light (inside the tin can) is reflected many times before incident on the hole

1

at each reflection energy / light is absorbed so (very) little light / energy leaves the hole

1

(b) the object absorbs all of the radiation incident on it
or
the object does not reflect or transmit any radiation
or
the object is the best possible emitter of radiation

1

(c) the intensity of every wavelength increases

1

the shorter the wavelength the more rapid the increase in intensity

1

the peak intensity occurs at shorter wavelength

1

(d) accept any value between 1600 (°C) and 10 000 (°C)

1

(e) the temperature has increased

1

as 200 years ago the energy / radiation from space = energy / radiation emitted (and reflected) into space

1

but now less radiation is emitted so there is a net absorption
allow energy for radiation

1

[10]

Q4.

(a) dark matt

1

light shiny

1

(b) B A C

1

biggest temperature difference (80 °C)
dependent on first mark

1

(c) (i) (the can that is) dark matt

1

best absorber (of infrared radiation)

1

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(ii) any **three** from:

- same area / shape of can
- surrounding temperature is the same for all cans
- same surface underneath cans
- same position in the room

3

(d) fox A

smaller ears

1

thicker fur

1

these minimise energy transfer

dependent on first 2 marks

1

[12]

Q5.

(a) (black) is a good absorber of (infrared) radiation

1

(b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)

melt is insufficient

1

unit mass / 1kg

1

(ii) 5.1×10^6 (J)

accept 5×10^6

*allow **1** mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$*

2

(c) (i) mass of <u>ice</u>

allow volume / weight / amount / quantity of <u>ice</u>

1

(ii) to distribute the salt throughout the ice

1

to keep all the ice at the same temperature

1

(iii) melting point decreases as the mass of salt is increased

allow concentration for mass

accept negative correlation

*do **not** accept inversely proportional*

1

(d) 60 000 (J)

accept 60 KJ

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*allow **2** marks for correct substitution ie E = 500 × 2.0 × 60*

*allow **2** marks for an answer of 1000 **or** 60*

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

*E = 500 × 2.0 **or** 0.50 × 2.0 × 60*

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

3

(e) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is *an attempt at a description of some advantages or disadvantages.*

Level 2 (3–4 marks)
There is a basic description of *some advantages **and** / **or** disadvantages for some of the methods*

Level 3 (5–6 marks)
There is a clear description of the advantages and disadvantages of all the methods.

examples of the points made in the response

extra information

energy storage

advantages:

- no fuel costs
- no environmental effects

disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

salt spreading

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

undersoil heating

advantages:

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- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

6

[18]

Q6.

(a) infrared / IR

correct answer only

1

(b) any **two** from:

- increase the power / watts

  allow increase the temperature of the oven or make the oven hotter
- decrease the speed

  allow leave the biscuits in for longer
- put biscuits through again

  increase radiation is insufficient

  ignore changes to the design of the oven

2

(c) (inside) surface is a (good) reflector or poor absorber (of IR)

Ignore bounce for reflect

surface is a (good) reflector of light does not score

surface is a (good) reflector of light and infrared / heat does score

1

(and) <u>outside</u> surface is poor emitter (of IR)

1

(so) increases the energy reaching the biscuits

allow reduces energy loss or makes oven more efficient

*do **not** accept no energy losses*

keeps oven hotter is insufficient

1

[6]

Q7.

(a) to reflect (the infrared)

accept (shiny surfaces) are good reflectors

ignore reference to incorrect type of wave

1

(b) black

1

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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]

Q8.

(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)*

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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

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]

Q9.

(a) (i) to check rise in temperature (of other thermometers) was due to the (different wavelengths of) light

accept as a control / comparison

to measure room temperature is insufficient

1

(ii) any **two** from three:

- different colours produce different heating effects / (rises in) temperatures
- red light produces the greatest heating effect / (rise in) temperature

or

- violet produces the least heating effect / (rise in) temperature
- all colours produce a greater heating effect than outside the spectrum

an answer

the longer the <u>wavelength</u> the greater the (rise in) temperature

or

the lower the <u>frequency</u> the greater the (rise in) temperature

gains both marks

2

(b) move a thermometer into the infrared region / just beyond the red light

allow use an infrared camera / infrared sensor

1

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the temperature increases beyond 24(°C)

accept temperature higher than for the red light

1

(c) $v = f \times \lambda$

9.4×10^{-6}

accept 9.375×10^{-6} or 9.38×10^{-6}

or

0.0000094

accept 0.000009375
***or** 0.00000938*
*allow **1** mark for correct substitution*
ie $3 \times 10^{8} = 3.2 \times 10^{13 \times \lambda}$

2

(d) at night the surroundings are cooler

accept at night the air is colder
there is no heat from the Sun is insufficient

or

at night there is a greater temperature difference between people and surroundings

1

(so surroundings) emit less infrared (than in daytime)

accept camera detects a greater contrast

or

gives larger difference in infrared emitted (between people and surroundings)

1

[9]

Q10.

(a) any **two** from:

- black is a good emitter of (infrared radiation)

  accept heat for radiation
  ignore reference to absorbing radiation

- large surface (area)

- matt surfaces are better emitters (than shiny surfaces)

  accept matt surfaces are good emitters
  ignore reference to good conductor

2

(b) 90% or 0.9(0)

$$efficiency = \frac{useful\ energy\ out\ (\times 100\%)}{total\ energy\ in}$$

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allow 1 mark for correct substitution, ie $\frac{13.5}{15}$
provided no subsequent step shown
*an answer of 90 scores **1** mark*
*an answer of 90 / 0.90 with a unit scores **1** mark*

2

(c) (producing) light
allow (producing) sound

1

(d) any **two** from:

- wood is renewable
  accept wood grows again / quickly
  accept wood can be replanted
- (using wood) conserves fossil fuels
  accept doesn't use fossil fuels
- wood is carbon neutral
  accept a description
  cheaper / saves money is insufficient

2

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

2 550 000
*allow **1** mark for correct substitution*
ie 100 × 510 × 50
provided no subsequent step shown
*answers of 1 020 000, 3 570 000 gain **1** mark*

2

joules /J
accept kJ / MJ
*do **not** accept j*
for full credit the unit and numerical answer must be consistent

1

[10]

Q11.

(a) (i) The volume of boiling water.

1

(ii) any **one** from:

- (more) precise
  *do **not** accept better (reading)*
- accurate

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- reliable

  *do **not** accept thermometer is unreliable*

- removes human / reading error

  accept easier to read
  accept take temperature more frequently

1

(b) **B**

marks are for the explanation

temperature falls faster

*this mark point cannot score if **A** chosen*

1

because black is a better / good emitter

ignore reference to better absorber
*accept for both marks an answer in terms of why **A** is the white can*

1

(c) (i) faster than

1

(ii) darker / black surfaces absorb heat faster

accept black is a better / good absorber
dark surfaces attract heat negates this mark

1

(iii) air is a <u>bad / poor</u> conductor
or
air is a good <u>insulator</u>

accept air is an insulator

1

[7]

Q12.

(i) *this mark only scores if a correct pair is chosen **and** a correct reason given*

A and **C**

<u>both</u> required and none other

or
B and **D**

<u>both</u> required and none other

only one (independent) variable
or
different shapes but the same colour

accept only the shape changes

1

(ii) **B** <u>radiates</u> heat faster

*converse answer in terms of **A** gains full marks*

1

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or
B is a better emitter (of heat)

but B has a smaller (surface) area
or
B has a smaller (surface) area: volume ratio

*allow **2** marks for both lose the same quantity / amount of heat in the same time*

***or** both have same rate of heat loss*

*allow **1** mark for both lose the same quantity / amount of heat*

1

(iii) any **one** from:

- transfer a lot of heat (too rapidly)
- water temperature drops too rapidly

  accept (significantly) more heat will be lost from the first radiator
- water too cold for the next radiator

  mention of absorption of heat negates mark

1

[4]

Q13.

(a) (i) convection

1

(ii) conduction

1

(b) (i) 2

1

black is the best absorber (of thermal energy / heat)

accept black is the best emitter (of thermal energy / heat)

note that a comparative is needed (eg better or best)

1

(ii) the colour of the metal plates

1

(iii) any **one** from:

- more precise / accurate / reliable

  *do **not** accept better reading*

  *do **not** accept thermometer is unreliable*
- can measure continuously
- take many readings in a small time
- removes (human) reading error

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accept easier to read

- can compare / draw graphs automatically
- records data automatically

1

(c) (i) radiation

accept radiates
accept infra red (IR) waves
*do **not** accept heat waves*

1

(ii) to reflect (heat away from the fire fighter)

accept it reflects
accept it is a poor absorber (of thermal radiation / heat)
*do **not** accept deflect / bounce for reflect*

1

(d) **N**

*the mark is for the reason which does not score if **M** is chosen*

transfers / absorbs less heat
or
gives smallest increase in temperature

accept will keep fire fighters cooler
*accept **N** is cooler (after 15 minutes)*
*an answer **N** goes up to 52°C and **M** goes up to 100°C is insufficient*

1

[9]

Q14.

(a) (i) radiation

ignore thermal / infrared

1

(ii) black is a better / good absorber (of heat / radiation)

ignore reference to black being a good emitter
black absorbs heat is insufficient
*do **not** accept black attracts / absorbs the Sun*
*do **not** accept black attracts heat*

1

(so) temperature rises faster

must be an indication of heating up quicker

or

white is a worse / poor absorber (of heat / radiation) (1)

accept white is a better / good reflector (of heat / radiation)

(so if white faces) temperature would rise slower (1)

ignore any reference to light

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1

(b) (i) 1.2 (hours) **or** 1 hour 12 minutes

no tolerance

1

(ii) increases (rapidly at first then increases at a slower rate)

*do **not** accept increases at a steady rate*

1

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

- (fill with) same mass / volume / amount of water
- same level of (sun)light / sunshine

  accept same heat / light source

  accept same place
- outside for the same (length of) time
- outside at same time (of day / year)
- initial water temperature
- the side of the bag facing the Sun

  *do **not** accept any factors to do with the construction of plastic bags eg thickness*

2

(ii) curved line drawn above given line

both lines must start from the same point

ignore if continues beyond one hour or levels off after 1 hour

*do **not** accept a straight line*

1

[8]

Q15.

(a) (i) silvered surfaces

more than the correct number of ticks in a row negates the mark

radiation

2

plastic cap

conduction, convection (both required)

	conduction	convection	radiation	
vacuum	✓	✓		
silvered surfaces			✓	(1)

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plastic cap	✓	✓		(1)

(ii)

any mention of air or any other substance in a vacuum scores zero

because there are no particles in a vacuum

accept atoms / molecules for particles

accept vacuum is empty space

accept there is nothing in a vacuum

accept there is no air / gas in the vacuum

conduction **and** convection need particles / medium

*need reference to both conduction **and** convection*

accept correct descriptions

2

(b) (i) less heat lost (to air above the heater)

*do **not** accept **no** heat lost*

light shiny surfaces are poor emitters (of radiation)

accept radiators for emitters
references to reflection are neutral

or dull, matt surfaces are good emitters (of radiation)

*do **not** credit answers which infer reflection from the underside of the hood*

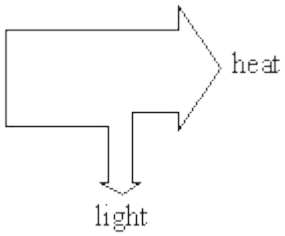
ignore correct reference to absorption

2

(ii) correct diagram drawn with one output arrow narrower than the other

ignore input

arrows correctly labelled with energy form
eg



flow charts score zero

2

(iii) energy cannot be destroyed

accept (principle of) conservation of energy

*do **not** accept because energy cannot be lost without clarification*

1

[9]

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Q16.

(a) the bigger the surface area, the faster the water cools down / temperature falls

answers must imply rate

accept heat for temperature provided rate is implied

*do **not** accept cools down more unless qualified*

1

(b) any **two** from:

the ears:

- have large surface / area

  not just has large ears

- radiate heat

  accept loses heat, but does not score if the reason given for heat loss is wrong

- keep blood cooler

2

(c) (i) radiation

1

(ii) conduction

1

[5]

Q17.

(a) conduction

*do **not** accept conductor*

1

(b) the freezer

both parts needed

greater <u>temperature</u> difference (between freezer and room)

*do **not** accept because it is the coldest*

1

(c) any **two** from:

- poor absorber of heat / radiation

  accept does not absorb heat poor emitter of heat / radiation is neutral

- reflects heat / radiation (from room away from fridge-freezer)

- reduces heat transfer <u>into</u> the fridge-freezer

- reduces power consumption of fridge-freezer

  *do **not** accept it is a bad conductor / good insulator*

2

[4]

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Q18.

(a) (i) 25 (%)

*do **not** accept ¼*

1

(ii) increases

1

(b) tick (✓) in top and bottom box

both required

1

(c) SHINY surfaces are good reflectors of infra-red radiation

accept white for shiny

or black surfaces are POOR reflectors of infra-red radiation

accept bad for poor
accept insertion of 'not' before 'good' in statement

or black surfaces are good EMITTERS of infra-red radiation

or black surfaces are good ABSORBERS of infra red radiation

1

[4]

Q19.

(a) the outside colour of the cans

1

(b) (i) 18 (°C) **or** 88 to 70

ignore negative sign

1

(ii) 8 (°C) **or** 70 to 62

ignore negative sign

1

(c) greater temperature difference between water and surroundings (at start)

must mention temperature difference
ignore just water hotter
accept energy used to heat cans initially

1

(d) black

1

temperature falls the fastest (in L)

accept (can L) loses more heat / cools quicker
accept heat for temperature

1

black is a good / the best / better emitter (of heat / radiation)

accept converse
ignore black is best absorber

1

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[7]

Q20.

(a) ions / electrons gain (kinetic) energy

accept atom / particles / molecules for ion
accept ions vibrate faster
accept ions vibrate with a bigger amplitude
accept ions vibrate more
do not accept ions move faster

1

(free) electrons transfer energy by collision with ions
or energy transferred by collisions between vibrating ions

1

(b) move faster or take up more space

*do **not** accept start to move / vibrate*

1

(warmer) water expands **or** becomes less dense (than cooler water)

*do **not** accept answers in terms of particles expanding*

1

warm water rises (through colder water) **or** colder water falls to take its place

1

(c) transfer of energy by waves / infrared (radiation)

accept rays for waves
*do **not** accept transfer of energy by electromagnetic waves*
ignore reference to heat

1

[6]

Q21.

(a) (i) vacuum

do not allow stopper

1

(ii) (absence of particles) means no (transfer of energy between) particles for conduction

*accept particles **or** atoms **or** molecules **or** electrons*

1

no movement of molecules for (transfer of energy by) convection

accept particles/atoms/electrons

if answer to (a)(i) is correct: then in (a)(ii) have stated 'conduction and convection both need a medium/particles/materials' = 2 marks

(If medium is specified, it must be correct, conduction can be solid, liquid or gas, convection must be liquid or gas)

if answer to (a)(i) is incorrect then in (a)(ii) have stated 'conduction and convection both need a medium...'= 1 mark, unless further qualified by stating about absence of particles, in which case get a second mark.

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1

(b) (i) silvered surface

accept silver surface

1

(ii) silvered is a bad emitter/radiator

1

surface reflects heat/energy/radiation (at inner and outer surface)
or is a bad absorber (of energy)

accept bounces off

1

[6]

Q22.

(i) radiation **or** infra red

*do **not** accept rays*
*do **not** accept waves*
accept electromagnetic waves

1

(ii) good absorber (of heat) to absorb heat (**or** infrared)

*do **not** accept 'attract' **or** 'capture' **or** soak*

1

(iii) reduce heat loss (from the panel)

accept (good) (heat) insulator
*accept stop **or** reduce conduction*
*accept stop **or** reduce convection*
accept traps heat
accept keeps water hot

1

(iv) to reflect (back into the panel) heat **or** infrared **or** Sun's energy

*do **not** accept 'bouncing'*
*do **not** accept reflect Sun*
*do **not** accept reflect sunlight **or** sun's rays*

1

radiated **or** given out by the (black) pipe

accept back to pipe
accept reduce heat loss for 1 mark
accept reduce heat loss by radiation for 2 marks
accept stop heat loss by radiation for I mark

1

[5]

Q23.

(a) (i) Carries heat up (as convection current)

1

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(ii) (1) By conduction or from molecule to molecule
(2) By radiation or as IR

2

(iii) Use shiny surface (inside or outside) or small area

1

(b) (i) Rise more quickly

1

(ii) Dull surface good absorber
(accept "attract" = "absorb" if context correct,
then penalise spg mark.

Shiny surface poor absorber

2

(c) (i) Fall more quickly

1

(ii) Dull surface good emitter
Shiny surface poor emitter

2

[10]

Q24.

(a) convection
air is heated by the burner / particles gain energy
air expands / particles move about more / particles move faster
air becomes less dense / particles are more spread out
air rises / particles rise - *not* heat rises
air from C moves into the heater / particles from C move into the heater to replace it / them

any four *for 1 mark each*

4

(b) (i) radiation

for one mark

1

(ii) black surface <u>radiates / emits</u> well
(*allow* absorbs and emits well) (*allow* comparison with shiny / white surfaces)

large surface area needed
high temperature (of the lumps)

any one for 1 mark

1

[6]

Q25.

absorber

1

reflector

1

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emitter

1

[3]

Q26.

(i) D, C **or** B, in either order, then A

tick or cross on the A

1

(ii) matt absorbs energy (better than shiny)

the converse arguments are acceptable

1

black absorbs energy (better than white)

1

[3]

Q27.

(a) radiates
absorbs / conducts
reflects

for 1 mark each

3

(b) C make sure the lamp is the same distance from both tubes
B switch on the lamp
A switch off the lamp
E wait for the temperature to stop rising
D read the thermometers

for 1 mark each

5

[8]

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