

GCSE Physics

Worksheet: Emission and absorption of infrared radiation

TIME 30 min	TOTAL 30 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Emission and absorption of infrared radiation

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

All objects emit and absorb infrared radiation.

0 1 . 1

Which statement is correct?

Tick (✓) **one** box.

- Only hot objects emit infrared radiation.☐
- All objects emit infrared radiation, whatever their temperature.☐
- Cold objects absorb infrared radiation but never emit it.☐
- Objects only emit infrared radiation when they glow.☐

[1 mark]

0 1 . 2

Two identical metal blocks are at temperatures of 20 °C and 80 °C.
Which block emits more infrared radiation each second?

.....

.....

[1 mark]

0 1 . 3

Give **one** example of an object that emits infrared radiation but does not glow.

.....

.....

[1 mark]

0 1 . 4

Name **one** device that detects infrared radiation.

.....

.....

[1 mark]

0 2

0 2 . 1

State whether a matt black surface is a good or a poor emitter of infrared radiation.

.....

.....

.....

.....

[1 mark]

0 2 . 2

State whether a shiny silver surface is a good or a poor absorber of infrared radiation.

.....

.....

.....

.....

[1 mark]

0 3

0 3 . 1

Which statement about infrared radiation is correct?

Tick (✓) **one** box.

Only objects above 100 °C emit infrared radiation.

☐

All objects emit and absorb infrared radiation, whatever their temperature.

☐

Only black objects emit infrared radiation.

☐

Infrared radiation can only be emitted, never absorbed.

☐

[1 mark]

0 3 . 2

Give **two** factors that affect how much infrared radiation a surface emits each second.

.....

.....

.....

.....

[2 marks]

0 4

A student uses a Leslie cube filled with hot water to compare how well matt black, shiny black, matt white and shiny silver surfaces emit infrared radiation, using an infrared detector placed at the same distance from each face in turn.

0 4 . 1

Write a hypothesis for this investigation.

.....

.....

[1 mark]

0 4 . 2

Identify the independent variable and the dependent variable, and state one variable that must be controlled.

.....

.....

.....

.....

.....

.....

[3 marks]

0 4 . 3

Give one hazard in this investigation and a suitable control measure.

[2 marks]

0 5

Houses in hot countries are often painted white or a light colour and have shiny metal roofs. Some radiators used to heat rooms are painted matt black.

0 5 . 1

Explain why a light-coloured, shiny house helps keep the inside cooler in a hot country.

[2 marks]

0 5 . 2

Explain why painting a radiator matt black, rather than leaving it shiny, helps it warm a room more effectively.

[2 marks]

0 6

A student is investigating how the type of surface affects the rate of emission of infrared radiation, using a Leslie cube and a detector.

0 6 . 1

Give **two** variables the student should keep the same for each surface, to make this a fair test.

.....

.....

.....

.....

[2 marks]

0 6 . 2

The student fills the cube with hot water once, and then tests the four surfaces at 5-minute intervals.

Explain why this could give unfair results, and suggest how the student could avoid the problem.

.....

.....

.....

.....

.....

.....

[3 marks]

0 7

Before starting, a student notices that an infrared detector reads 0.3 units even when pointed away from the Leslie cube, because of background infrared radiation in the room. The student then takes three readings from the matt black face: 8.9, 9.3 and 9.1 (detector units).

0 7 . 1

What does the 0.3 reading, taken with the detector pointed away from the cube, show?

Tick (✓) **one** box.

A random error

☐

A zero error

☐

An anomalous result

☐

[1 mark]

0 7 . 2

Explain how the student should deal with this error when processing all of their readings.

.....

.....

.....

.....

[2 marks]

0 7 . 3

Calculate the mean of the three readings from the matt black face, and the uncertainty in the mean using the range of the readings.

.....

.....

.....

.....

.....

[2 marks]

0 7 . 4

Calculate the mean reading from the matt black face, corrected for the zero error.

.....

.....

.....

Corrected mean reading =

[1 mark]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Physics · Worksheet: Emission and absorption of infrared radiation · 30 marks

Question 1 (4 marks)

01.1 [1 mark]

Correct: All objects emit infrared radiation, whatever their temperature.

01.2 [1 mark]

Answer: The block at 80 °C

- the block at 80 °C / the hotter block (1)
-

01.3 [1 mark]

Answer: A person (or a hot drink, or a radiator).

- a person / a hot drink / a warm radiator / an animal / an iron (1)
-

01.4 [1 mark]

Answer: An infrared (thermal imaging) camera.

- infrared camera / infrared thermometer / infrared detector / thermal imaging camera (1)
-

Question 2 (2 marks)

02.1 [1 mark]

Answer: A good emitter.

- a good emitter (1)
-

02.2 [1 mark]

Answer: A poor absorber.

- a poor absorber (1)
-

Question 3 (3 marks)

03.1 [1 mark]

Correct: All objects emit and absorb infrared radiation, whatever their temperature.

03.2 [2 marks]

Answer: Temperature and the type of surface (colour/texture).

- the temperature of the surface (1)
- the type of surface (its colour and texture, e.g. matt or shiny) (1)

Notes: Allow the surface area for either mark.

Question 4 (6 marks)

04.1 [1 mark]

Answer: The matt black surface emits infrared radiation at the fastest rate (matt black is the best emitter) and the shiny silver surface emits it at the slowest rate.

- the matt black surface emits infrared radiation fastest (is the best emitter) and the shiny silver surface emits it slowest (is the worst emitter) (1)
-

04.2 [3 marks]

Answer: Independent: the type of surface (colour and texture) of each face. Dependent: the amount of infrared radiation emitted in a given time (the detector reading). Control: the distance of the detector from each face.

- independent variable: the type of surface (colour/texture) of each face (1)
 - dependent variable: the amount of infrared radiation emitted in a given time / the reading on the infrared detector (1)
 - a control variable, e.g. the distance of the detector from the surface, or the temperature of the water when each face is measured (take the readings quickly, one after another) (1)
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04.3 [2 marks]

Answer: The hot water used to fill the cube could scald if spilled; fill the cube carefully using a funnel, and use a heatproof mat.

- a hazard, e.g. the hot water could scald if spilled, or the cube itself is hot to touch (1)
 - a control measure that matches the hazard, e.g. fill carefully using a funnel, use a heatproof mat, or avoid direct contact with the hot cube (1)
-

Question 5 (4 marks)

05.1 [2 marks]

Answer: A light, shiny surface absorbs little solar radiation, so less energy is transferred into the house.

- a light, shiny surface is a poor absorber of infrared radiation from the Sun (1)
- so less of the Sun's radiation is absorbed by the house, keeping it cooler inside (1)

05.2 [2 marks]

Answer: Matt black is a good emitter, so the radiator radiates energy into the room more effectively.

- a matt black surface is a good emitter of infrared radiation (1)
- so the radiator transfers energy to the room by radiation more effectively than a shiny radiator would (1)

Question 6 (5 marks)

06.1 [2 marks]

Answer: Any two: the water temperature when reading, the detector's distance from the surface, and the timing.

- the temperature of the water in the cube each time a reading is taken (1)
- the distance between the detector and the surface (1)
- the length of time the reading is taken over (1)
- the volume of water in the cube (1)

Any 2 of the points above.

06.2 [3 marks]

Answer: The cube cools between tests, so later surfaces give unfairly low readings; take all four readings quickly one after another (or refill with water at the same temperature before each test).

- the water (and the cube) cools down during the investigation, so later surfaces are tested at a lower temperature (1)
 - a surface tested later would give a lower reading, not because it is a poorer emitter but because the cube is cooler by then (1)
 - take the readings for all four surfaces quickly, one straight after another (while the temperature is the same) / refill with hot water at the same starting temperature before testing each surface (1)
-

Question 7 (6 marks)

07.1 [1 mark]

Correct: A zero error

07.2 [2 marks]

Answer: Subtract 0.3 from every detector reading taken from the cube, so that this background (zero-error) contribution is removed from every result.

- subtract 0.3 from every reading taken from the cube (1)
 - so the background/zero-error contribution is removed from all the results, not just one reading (1)
-

07.3 [2 marks]

Answer: Mean = 9.1, uncertainty = ± 0.2 (detector units)

- mean = $(8.9 + 9.3 + 9.1) \div 3 = 9.1$ (1)
 - uncertainty = $\pm$ half the range = $\pm (9.3 - 8.9) \div 2 = \pm 0.2$ (1)
-

07.4 [1 mark]

Answer: 8.8 (detector units)

- $9.1 - 0.3 = 8.8$ (1)

Notes: Allow ECF from an incorrect mean.
