



Unit 7 • Energy in Daily Life: heat

Full marks 37

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. transmission of heat
2. conduction
3. insulators
4. thermal conductivity
5. convection
6. radiation
7. mechanical
8. greenhouse effect

K • 4

Each carries 0.5 mark.

2 Label the diagram

1. cap (also a cup)
2. insulating stopper stops convection and evaporation at the top
3. double glass walls
4. vacuum (no air) stops conduction and convection
5. silvered surfaces reflect heat rays back: stop radiation
6. insulating support

K • 3

Each carries 0.5 mark.

3 Multiple choice

i. b. convection

K • 1

In convection the heated particles of a liquid or gas **move**, carrying the heat. In conduction they stay in place; radiation needs no particles at all. Temperature is not a way of transferring heat.

ii. c. by radiation

K • 1

Conduction and convection both need particles of matter. Only radiation, which travels as electromagnetic waves, can cross a vacuum. Transpiration is the loss of water from leaves.

iii. a. a spoon kept in sunlight gets hot

U • 1

The Sun's heat reaches the spoon across space and air as radiation. The spoon in tea and the water around the rod are heated by conduction (direct contact). Above the lamp, the spoon is heated mostly by the rising hot gases: convection.

iv. b. copper or aluminium

A • 1

Copper and aluminium have the highest thermal conductivity of these, so they spread the flame's heat quickly across the whole base. That is why many steel pans have a copper or aluminium layer in the bottom. Glass and wood conduct heat poorly.

v. c. the silvered surfaces

U • 1

Heat rays can cross a vacuum (that is how sunlight reaches us), so the vacuum alone can't stop radiation. The **silvered** surfaces reflect the heat rays back towards the liquid. The vacuum stops conduction and convection; the stopper stops convection out of the top.

4 Very short answers

a. MARKING SCHEME

K • 1

✓ Any two of: carbon dioxide, water vapor, methane, nitrous oxide, CFCs.

b. MARKING SCHEME

K • 1

✓ 3×10^8 m/s (the speed of light).



- c. MARKING SCHEME U · 1
✓ About -18°C (instead of about 15°C).

5 Short answers

- a. MARKING SCHEME U · 2
✓ Thick mud walls are poor conductors of heat.
✓ So the outside heat takes a long time to get in in summer, and the warmth inside escapes only slowly in winter.
- b. MARKING SCHEME U · 2
✓ Warm, used air is less dense, so it rises to the top of the room (convection).
✓ A ventilator high up lets it out, while fresh, cooler air comes in lower down.
- c. MARKING SCHEME U · 2
✓ Light colors reflect most of the Sun's radiation and absorb little of it.
✓ So less heat reaches the body and we feel cooler (dark clothes absorb more and get hot).
- d. MARKING SCHEME U · 2
✓ Any one difference, e.g. a sea breeze blows by day, a land breeze at night.
✓ Any second difference, e.g. a sea breeze blows from the sea to the land, a land breeze from the land to the sea; or in a sea breeze the land is hotter and air rises over it, in a land breeze the sea is warmer and air rises over it.

6 Long answers

- a. ANSWER K · 4

Convection is the transfer of heat in a liquid or a gas by the actual movement of its particles: the heated part becomes less dense and rises, and the cooler, denser part sinks to take its place, setting up a convection current.

Uses:

1. Water and other liquids in a pot are heated by convection.
2. Room heaters, fans and air conditioners warm or cool a whole room by moving air.
3. In many refrigerators the freezer is at the top, so that the air it cools sinks and warmer air rises to it.
4. Ventilators near the ceiling let warm, stale air out of a room.
5. Hot-air balloons rise because hot air is less dense than the air around.
6. In nature, convection causes winds, sea and land breezes, clouds and rain.

MARKING SCHEME

- ✓ Convection is the transfer of heat in a liquid or a gas by the actual movement of its particles (the heated part becomes less dense and rises).
- ✓ Any one use, e.g. water in a pot is heated by convection.
- ✓ A second use, e.g. room heaters, fans and air conditioners move air round a room; ventilators; the freezer at the top of a fridge.
- ✓ A third use, e.g. hot-air balloons; winds, sea and land breezes, clouds and rain.



b. ANSWER

U • 4

The greenhouse effect is the warming of the Earth's surface because greenhouse gases in the air (carbon dioxide, water vapor, methane, nitrous oxide, CFCs) absorb the long-wave heat radiation given out by the Earth and send part of it back down, instead of letting it all escape into space.

Importance:

1. It keeps the Earth's average temperature at about 15 °C; without it, the Earth would be about -18 °C and frozen, and life would hardly be possible.
2. In artificial greenhouses, farmers grow off-season vegetables and earn a good income.
3. Plants that can't survive the cold can be protected in greenhouses.
4. Plants of hot places can be grown even in cold countries.

(Too strong a greenhouse effect, caused by extra greenhouse gases, leads to global warming.)

MARKING SCHEME

- ✓ The warming of the Earth's surface because greenhouse gases in the air absorb the long-wave heat radiation given out by the Earth and send part of it back down.
- ✓ It keeps the Earth's average temperature at about 15 °C; without it the Earth would be about -18 °C and frozen.
- ✓ In artificial greenhouses, off-season vegetables can be grown and sold at a good price.
- ✓ Plants that can't survive the cold, or plants of hot places, can be grown in greenhouses even in cold places.

7 Numerical problems**a. ANSWER**

A • 2

450 kcal = $450 \times 1000 = 450,000$ calories. Energy = $450,000 \times 4.2 = 1,890,000$ J (about 1.9 million joules).

MARKING SCHEME

- ✓ 450 kcal = 450,000 calories, multiplied by 4.2.
- ✓ 1,890,000 J.

b. ANSWER

A • 2

$t = 8 \times 60 + 20 = 500$ s. Distance = speed $\times$ time = $3 \times 10^8 \times 500 = 1.5 \times 10^{11}$ m (150 million km).

MARKING SCHEME

- ✓ $t = 500$ s, and distance = speed $\times$ time written.
- ✓ 1.5×10^{11} m (150 million km).

8 Think**ANSWER**

HA • 2

On Earth, the hot gases from the flame are less dense than the air around, so they rise and pull the flame up into a point: convection. In space nothing is "up" and hot gases don't rise, so there is no convection; the flame spreads equally in all directions and stays round.

MARKING SCHEME

- ✓ On Earth the hot, less dense gases rise (convection), drawing the flame up into a point.
- ✓ In space hot gases don't rise, so there is no convection current and the flame stays round.



9 Activity: Which box gets hottest? (Activity 7.6)

(not marked)

WHAT STUDENTS SHOULD FIND

The black box gets hottest: dark, dull surfaces absorb most of the radiation that falls on them. The white and shiny boxes stay cooler, because they reflect most of the sunlight.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **Which Feels Cooler?** (exhibit): Touch both: they're at the same temperature, but the metal takes your heat faster.
- **Lava Lamp — Convection in Motion** (exhibit): Watch the wax: warmed at the bottom it rises, cools at the top and sinks again.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	15	15	5	2	37





Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. reflection of light
2. concave
3. convex
4. pole
5. focal length
6. real image
7. frequency
8. amplitude

K • 4

Each carries 0.5 mark.

2 Label the diagram

- | | | |
|-------------------|--------------------------|-------|
| 1. F | 4. radius of curvature R | K • 3 |
| 2. C | 5. P | |
| 3. principal axis | 6. focal length f | |

Each carries 0.5 mark.

3 Multiple choice

- i. b. concave mirror

K • 1

Only a concave mirror makes reflected rays actually meet, forming a real image (when the object is beyond F). Plane and convex mirrors always form virtual images.

- ii. b. is reflected back along the same path

U • 1

A ray through C strikes the mirror square on (along its radius), so it is reflected straight back along its own path.

- iii. b. 20 Hz to 20 kHz

K • 1

A healthy human ear hears from about 20 Hz to 20,000 Hz (20 kHz). Below that is infrasound; above it, ultrasound.

- iv. b. bat

K • 1

Bats find insects and their way in the dark by making ultrasound and listening for the echoes. Elephants and blue whales use the opposite end, very low infrasound. (Dolphins and some toothed whales, like sperm whales, do use ultrasound, but the best-known answer is the bat.)

- v. a. it is more

U • 1

The intensity is proportional to the square of the amplitude, so a bigger amplitude means a more intense, louder sound.

4 Very short answers

- a. MARKING SCHEME

A • 1

✓ 20 cm ($f = R/2$).

- b. MARKING SCHEME

K • 1

✓ A convex mirror.

- c. MARKING SCHEME

K • 1

✓ Hertz (Hz).



5 Short answers

a. MARKING SCHEME

U • 2

- ✓ A concave mirror is a converging mirror: it reflects the Sun's (nearly parallel) rays to one point, its focus.
- ✓ The heat of a large area of sunlight is gathered on the pot placed there, so it gets hot enough to cook.

b. MARKING SCHEME

U • 2

- ✓ A real image forms only where reflected rays actually meet.
- ✓ Convex and plane mirrors make the reflected rays spread out, so they never meet in front of the mirror; they only seem to meet behind it (virtual image).

c. MARKING SCHEME

U • 2

- ✓ Any one difference, e.g. a real image is formed where the reflected rays actually meet; a virtual image where they only appear to meet.
- ✓ Any second difference, e.g. a real image can be obtained on a screen, a virtual one can't; or a real image is inverted and in front of the mirror, a virtual one erect and behind it.

d. MARKING SCHEME

U • 2

- ✓ The intensity of sound decreases with distance: its energy spreads over a bigger and bigger area.
- ✓ On the way some energy is also absorbed (and reflected) by the air, so less reaches the listener.

6 Long answers

a. ANSWER

U • 4

Concave mirror	Convex mirror
The reflecting surface is curved inwards (hollow).	The reflecting surface bulges outwards.
Converges parallel rays: a converging mirror.	Diverges parallel rays: a diverging mirror.
Its focus is in front of the mirror and real.	Its focus is behind the mirror and virtual.
Forms real, inverted images (virtual, erect, magnified when the object is between F and P).	Always forms virtual, erect, diminished images.
Used in torches, headlights, shaving mirrors, solar cookers.	Used as side mirrors of vehicles, at road bends, in street lamps.

MARKING SCHEME

- ✓ Concave: reflecting surface curved inwards; convex: bulges outwards.
- ✓ Concave converges parallel rays (converging mirror); convex diverges them (diverging mirror).
- ✓ Concave: focus in front of the mirror, real; convex: focus behind it, virtual.
- ✓ Concave forms real, inverted images (except object between F and P); convex always virtual, erect, diminished; or their uses. Any one difference per point.



b. ANSWER

K · 4

A sound wave with a frequency above 20 kHz, too high for humans to hear, is an ultrasonic wave (ultrasound). Uses: in ultrasonography (USG), to see a baby in the womb and find stones and tumors in the internal organs; in SONAR, to find the depth of the sea and locate fish shoals and wrecks; to clean medical instruments and jewelry and kill bacteria; to break up kidney stones without cutting.

MARKING SCHEME

- ✓ Sound with a frequency above 20 kHz, which humans can't hear.
- ✓ Any one use, e.g. ultrasonography (USG) of a baby or the internal organs.
- ✓ A second use, e.g. SONAR, to find the depth of the sea or locate fish and wrecks.
- ✓ A third use, e.g. cleaning instruments and killing bacteria; breaking up kidney stones without cutting.

7 Numerical problems

a. ANSWER

A · 2

$$\lambda = v/f = 332 \div 10 = 33.2 \text{ m.}$$

MARKING SCHEME

- ✓ $\lambda = v/f = 332 \div 10$.
- ✓ 33.2 m.

b. ANSWER

A · 2

Depth = (speed × time) ÷ 2 = (1500 × 4) ÷ 2 = 3000 m. (Divided by 2 because the sound goes down and back up.)

MARKING SCHEME

- ✓ Depth = (speed × time) ÷ 2 = (1500 × 4) ÷ 2.
- ✓ 3000 m (3 km).

c. ANSWER

A · 2

$$I = P/A, \text{ so } P = I \times A = 2 \times 10^{-5} \times 6 = 1.2 \times 10^{-4} \text{ W.}$$

MARKING SCHEME

- ✓ $P = I \times A = 2 \times 10^{-5} \times 6$.
- ✓ $1.2 \times 10^{-4} \text{ W.}$

8 Think

ANSWER

HA · 2

About $9 \div 3 = 3$ km away. Light travels at 3×10^8 m/s and reaches her almost at once, but sound travels at only about 340 m/s, so the thunder arrives later.

MARKING SCHEME

- ✓ About 3 km ($9 \div 3$).
- ✓ Light (3×10^8 m/s) is far faster than sound (about 340 m/s), so the flash arrives almost at once and the thunder later.

9 Activity: Catching an image on a card (Activity 7.11)

(not marked)

WHAT STUDENTS SHOULD FIND

Only the concave mirror gives a picture on the card: small, sharp and upside down, a real image. The card is then at about the mirror's focal length, because light from the distant window arrives almost parallel. Convex and plane mirrors give no picture on the card: their images are virtual.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **The Infinity Well** (exhibit): Two facing mirrors bounce the lights back and forth, each image dimmer and farther away.



- **Anamorphic Illusion — A Hidden Image Revealed** (exhibit): The stretched picture looks right in the curved mirror: a convex surface squeezes it back.
- **Catch a Real Image** (exhibit): Put your hand where the image floats: it's real, made where the reflected rays meet.
- **The Mirascope — A Real Image in Mid-Air** (exhibit): The ball on top isn't there: two concave mirrors make a real image you can't quite touch.
- **The Concave Mirror — A Swinging Reflection** (exhibit): Walk towards the concave mirror: past its focus your image flips upright and grows.
- **The Chime Instrument** (exhibit): Strike a short bar, then a long one: the short bar vibrates faster and sounds higher.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	16	14	7	2	39

