2. Thermal physics

2.2 Thermal properties and temperature

Paper 1 and 2

Question Paper

Paper 1

Questions are applicable for both core and extended candidates

1 A metal object is heated strongly in an oven.

What happens to the volume of the object and the internal energy stored in the object?

	volume	internal energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

2 Which row describes the process of melting?

	initial state	final state	change in temperature
A	liquid	gas	yes
B	liquid	solid	no
C	solid	gas	yes
D	solid	liquid	no

3 Which name is given to the change of state when steam at 100 °C changes to water at 100 °C?

A boiling

B condensation

C evaporation

D melting

4 There is a vacuum between the double walls of a vacuum flask.

Which types of thermal transfer are reduced by the vacuum?

A conduction, convection and radiation

B conduction and convection only

C conduction and radiation only

D convection and radiation only

5 Some terms describing changes of state are listed.

1 boiling

2 solidification

3 condensation

4 evaporation

Which two terms identify the same change of state?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

6 What increases when the temperature of a copper block increases?

A the number of copper atoms in the block

B the melting point of the block

C the internal energy of the block

D the density of the block

7 A textbook gives the description of a thermal process as 'more-energetic molecules escape from the surface of a liquid which causes the liquid to cool'.

Which process is being described?

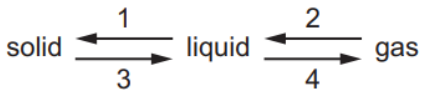
A boiling

B Brownian motion

C condensation

D evaporation

8 The diagram shows the changes in state, 1, 2, 3 and 4, between solids, liquids and gases.



What are processes 2 and 3?

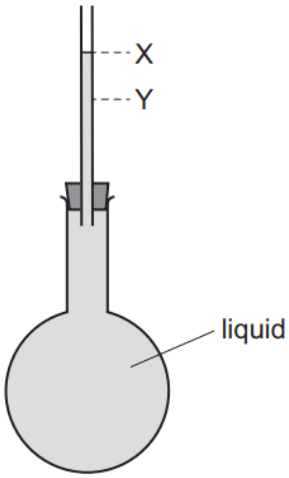
	2	3
A	condensation	melting
B	condensation	freezing
C	evaporation	melting
D	evaporation	freezing

9 Copper has a melting point of 1100 °C.

What is the melting point in kelvin?

A 727 K **B** 827 K **C** 1373 K **D** 1473 K

10 A liquid at room temperature fills a flask and a glass tube to level X.



The flask is placed in ice and the liquid level in the tube changes to level Y.

Why does the level change to level Y?

A The flask contracts.

B The flask expands.

C The liquid contracts.

D The liquid expands.

11 A liquid is evaporating. The liquid is **not** boiling.

Which statement about the liquid at an instant in time is correct?

A Any molecule can escape and from any part of the liquid.

B Any molecule can escape, but only from the liquid's surface.

C Only molecules with enough energy can escape and only from the liquid's surface.

D Only molecules with enough energy can escape, but from any part of the liquid.

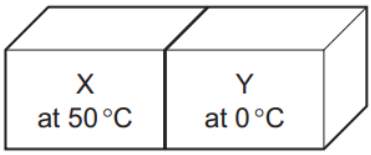
12 The melting point of mercury is –39 °C.

What is the melting point of mercury in kelvin?

A –234 K **B** 61 K **C** 234 K **D** 312 K

13 A student has two blocks of metal, X and Y. The temperature of X is 50 °C and the temperature of Y is 0 °C.

The two blocks are placed in contact with each other, as shown.

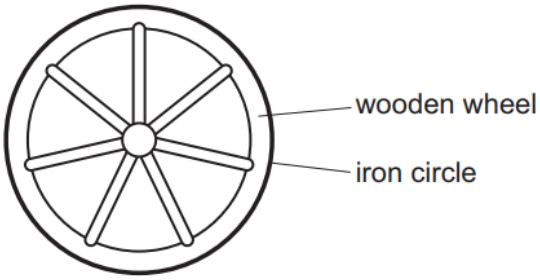


After some time, both blocks have a temperature of 25 °C.

What has happened to the internal energy of each block?

	internal energy of X	internal energy of Y
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	unchanged	unchanged

14 A wooden wheel can be strengthened by putting a tight circle of iron around it.



Which action would make it easier to fit the circle over the wood?

A cooling the iron circle only

B heating the iron circle

C heating the wooden wheel and cooling the iron circle

D heating the wooden wheel but not heating or cooling the iron circle

15 Which diagram shows the processes happening during changes of state?

A

gas —boiling→ liquid —solidification→ solid

B

gas —condensation→ liquid —melting→ solid

C

solid —melting→ liquid —boiling→ gas

D

solid —solidification→ liquid —boiling→ gas

16 Which statements about evaporation of water are correct?

1 Evaporation causes the remaining liquid to cool.

2 During evaporation, the more energetic particles escape from the surface of the liquid.

3 Evaporation only happens at 100 °C.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

17 At the surface of a liquid, the more energetic molecules can escape from the liquid into the atmosphere.

Which name is given to this process?

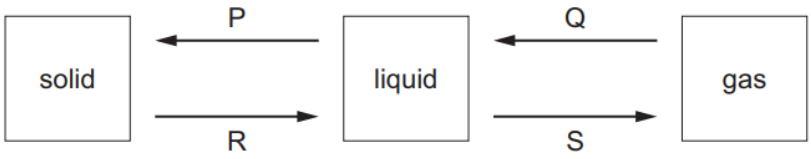
A boiling

B condensation

C evaporation

D melting

18 In the diagram, each box represents a state of matter and each arrow represents a change of state.



Which row correctly identifies the changes of state?

	P	Q	R	S
A	freezing	condensation	boiling	melting
B	boiling	melting	condensation	freezing
C	freezing	condensation	melting	boiling
D	condensation	freezing	melting	boiling

19 Which statement about the motion of molecules describes the process of evaporation?

A Molecules break free from their fixed positions.

B Freely moving molecules collide and join together.

C Molecules escape from the surface of a liquid.

D Freely moving molecules gain energy and move further apart.

20 What happens to a solid when its temperature increases?

A It contracts.

B Its density increases.

C Its internal energy increases.

D Its molecules move freely.

21 Two thermometers, P and Q, give the same reading at room temperature.

The bulb of thermometer Q is wrapped in gauze and dipped in a beaker of water at room temperature.

Air at room temperature is blown over the two thermometer bulbs.

Which statement correctly describes and explains what happens?

A P reads higher than Q because bulb P absorbs energy from the air.

B P reads higher than Q because water evaporates from the gauze and cools bulb Q.

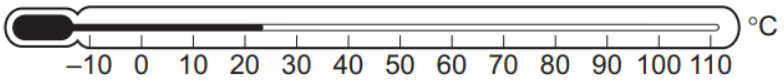
C P reads lower than Q because the wet gauze insulates bulb Q.

D P reads lower than Q because water evaporates from the gauze and warms bulb Q.

22 What happens to the volumes of liquid metal and of solid metal when heated at constant pressure?

	volume of liquid metal	volume of solid metal
A	decreases	increases
B	decreases	no change
C	increases	increases
D	increases	no change

23 The diagram shows a liquid-in-glass thermometer.



A student wishes to check the marking of the upper fixed point on this thermometer.

What should she do?

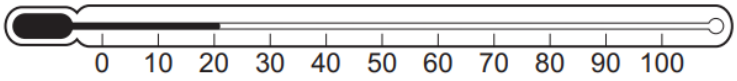
A Put the bulb in a beaker of boiling sea water.

B Put the bulb in a beaker of boiling pure water.

C Put the bulb in a beaker of ice and salt.

D Put the bulb in a beaker of pure melting ice.

24 The diagram shows a liquid-in-glass thermometer.



Which physical property of the thermometer is used to measure temperature?

A expansion of glass

B expansion of liquid

C mass of glass

D mass of liquid

25 An engineer investigates the increase in temperature of the oil in a car engine when it is first switched on.

Which row is correct?

	change in internal energy	explanation
A	increase	The random kinetic energy of the particles increases.
B	increase	The oil evaporates when it is heated.
C	decrease	The potential energy of the particles increases.
D	decrease	The oil changes state to a gas when it is heated.

26 Why are small gaps left between the metal rails of a railway track?

A to allow for expansion of the rails on a hot day

B to allow for contraction of the rails on a hot day

C to allow for expansion of the rails on a cold day

D to allow for contraction of the rails on a cold day

27 The temperature of the gas in a sealed container of constant volume decreases from 20 °C to 12 °C.

Which row is correct?

	pressure of the gas in the container	average speed of the molecules of gas
A	decreases	decreases
B	stays the same	increases
C	increases	stays the same
D	stays the same	decreases

28 A teacher makes the statement, 'Object P has a higher thermal capacity than object Q.'

What does this statement mean?

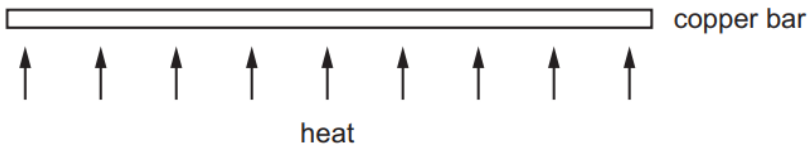
A Object P has a higher melting point than object Q.

B Object P has a lower melting point than object Q.

C The increase in temperature of object P is greater than that of object Q for the same increase in internal energy.

D The increase in temperature of object P is smaller than that of object Q for the same increase in internal energy.

29 A long, thin bar of copper is heated gently and evenly along its length.



What happens to the bar?

A It becomes less heavy.

B It becomes longer.

C It becomes shorter.

D It bends at the ends.

30 A person taking a shower notices that water appears on the inside of the bathroom window, even though the window is some distance from the shower.

Which statement explains this observation?

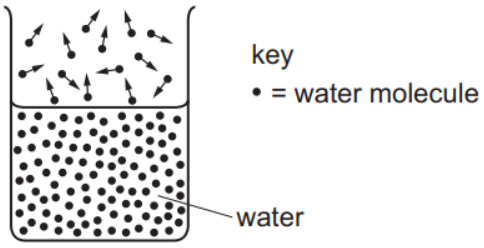
A Droplets of water from the hot shower move through the air and onto the window.

B The colder window causes the steam in the atmosphere to solidify.

C Water vapour from the atmosphere condenses onto the colder window.

D The hot water boils and turns into steam.

31 The diagram shows the more energetic water molecules escaping from the surface of liquid water.



What is this process called?

A Brownian motion

B condensation

C evaporation

D conduction

32 The table shows the melting and boiling points of four different substances.

Which substance becomes a liquid when placed in a beaker of boiling water?

	melting point / °C	boiling point / °C
A	10	90
B	40	150
C	105	230
D	110	320

33 Wet clothes are put out on a line to allow the water in the clothes to evaporate.

Which type of weather would cause the water to evaporate most quickly?

A a cold day with no wind

B a cold day with wind

C a hot day with no wind

D a hot day with wind

34 A scientist measures the air temperature at different heights from the floor in a cave. The results are recorded in the table.

height / m	temperature / °C
0	10
10	11
20	13
30	14
40	16

Why does altering the height affect the temperature of the air?

A The molecules in warm air have less energy than the molecules in cool air.

B The molecules in cool air are further apart than the molecules in warm air.

C Warm air is less dense than cool air.

D Cool air rises above warm air.

35 The thermometer in the diagram has no scale.

Before this thermometer can be used to measure temperature, two standard temperatures known as fixed points are needed. These are labelled X and Y.

Which row describes these fixed points on the Celsius scale?

	X	Y
A	temperature of pure boiling water	normal body temperature
B	temperature of pure boiling water	temperature of pure melting ice
C	normal body temperature	temperature of pure boiling water
D	temperature of pure melting ice	temperature of pure boiling water

36 When a hot gas is left to cool, its internal energy decreases.

What causes this?

A a decrease in the kinetic energy of the gas particles

B a decrease in the gravitational potential energy of the gas particles

C an increase in the average speed of the gas particles

D an increase in the average distance of separation of the gas particles

37 When a bridge is built, a gap is left between each concrete slab.

Why are these gaps left?

A Concrete expands on warm days.

B Concrete contracts on warm days.

C The gaps expand on warm days.

D The gaps contract on cold days.

38 Evaporation occurs from the surface of a pool of water.

Which statement describes this change of state?

A Electrons move from the liquid and become a gas.

B Molecules that move from the liquid have the same energy as those that stay in the liquid.

C The more energetic molecules escape the liquid.

D The more energetic molecules remain in the liquid.

39 Which statement about the evaporation of a liquid is correct?

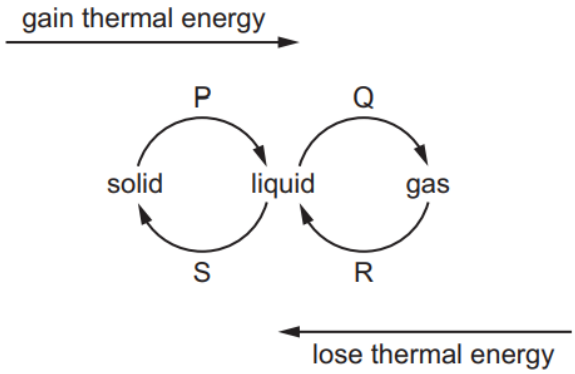
A The least energetic molecules escape from the surface and the temperature of the liquid decreases.

B The least energetic molecules escape from the surface and the temperature of the liquid increases.

C The most energetic molecules escape from the surface and the temperature of the liquid decreases.

D The most energetic molecules escape from the surface and the temperature of the liquid increases.

40 The diagram shows the changes of state P, Q, R and S that occur in solids, liquids and gases when they gain or lose thermal energy.



What is the name of change R?

A condensation

B solidification

C boiling

D melting

41 Which row describes the process of condensation?

	change of state	separation of molecules
A	gas to liquid	decreases
B	gas to liquid	increases
C	liquid to gas	decreases
D	liquid to gas	increases

42 Which row gives the correct name for each change of state shown?

	change of state		
	gas to liquid	liquid to solid	solid to liquid
A	condensation	melting	solidification
B	condensation	solidification	melting
C	evaporation	melting	solidification
D	evaporation	solidification	melting

43 Which effect is caused by thermal expansion?

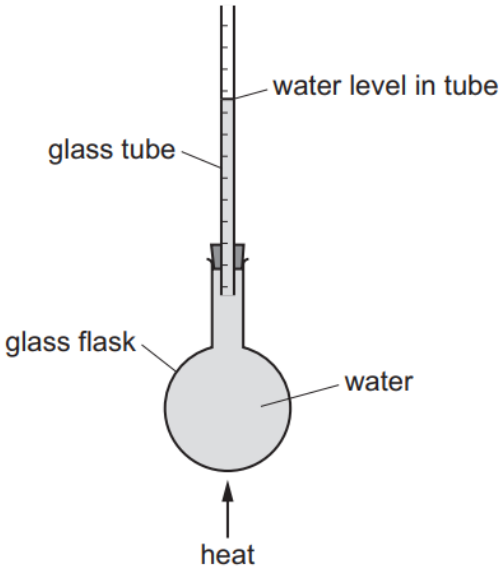
A a metal surface heating up in direct sunlight

B ice-cream melting on a hot day

C a railway track buckling on a hot day

D ice forming on a pond on a cold day

44 Some water in a glass flask is gently heated.



Why does the water level in the glass tube rise during heating?

A Only the glass flask expands.

B Only the water expands.

C The glass flask expands more than the water.

D The water expands more than the glass flask.

45 What happens when a metal block is heated?

A Its breadth, height and length all increase.

B Its width increases only.

C Its height increases only.

D Its length increases only.

Paper 2

Questions are applicable for both core and extended candidates unless indicated in the question

46 A very hot mug of coffee is near a large unheated swimming pool holding 2.0×10^6 kg of water.

Which statement is correct?

A If the mug of coffee is tipped in the pool, the coffee will lose much more internal energy than the water in the pool gains.

B The internal energy of a substance depends only on its temperature.

C The internal energy of the water in the pool is lower than the internal energy of the mug of coffee.

D When the temperature of the mug of coffee falls, its internal energy will decrease.

47 A student measures the mass of water in an open container over two hours. The container is kept in a warm room. The results are in the table.

time / hours	mass of water / g
0.0	33.9
0.5	30.6
1.0	27.6
1.5	24.9
2.0	22.5

Why does the mass of the water change?

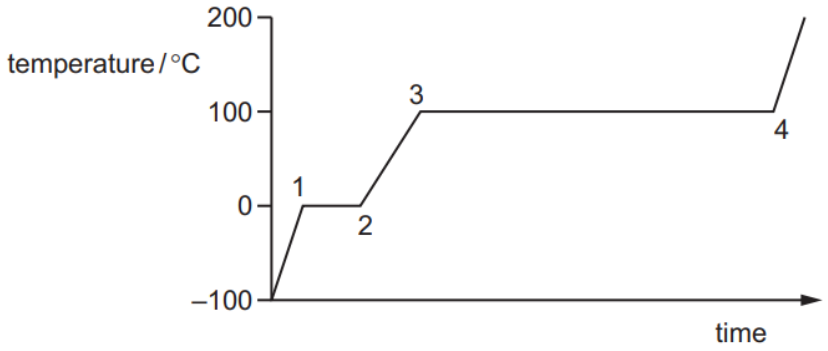
A The water evaporates.

B The water freezes.

C The water condenses.

D The water boils.

48 A block of ice is at a temperature of –100 °C. Energy is supplied at a constant rate. The graph shows how its temperature changes.



At which points have the ice completely changed state to water and all the water completely changed state to steam?

	completely changed to water	completely changed to steam
A	1	3
B	1	4
C	2	3
D	2	4

49 In an experiment to measure specific heat capacity, a block of aluminium is heated and its rise in temperature is measured.

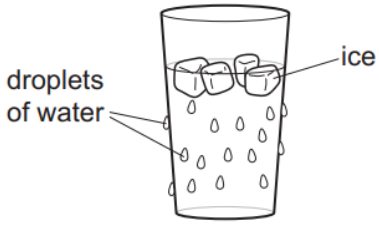
The internal energy gained by the block is ΔE. The mass of the block is m. The rise in temperature of the block is ΔT.

Which expression gives the specific heat capacity of aluminium? **(extended only)**

A $\frac{m}{\Delta E \Delta T}$ **B** $\frac{m\Delta T}{\Delta E}$ **C** $\frac{\Delta E}{m\Delta T}$ **D** $\frac{\Delta E \Delta T}{m}$

50 A man puts some ice into a glass of water on a warm day.

After a short time, he notices that the ice disappears and that water droplets appear on the outside of the glass.



Which two changes of state are taking place?

A condensation and freezing

B condensation and melting

C boiling and melting

D freezing and evaporation

51 During evaporation of a liquid, the most energetic particles escape. The temperature of the remaining liquid changes.

Which row identifies where these particles escape from and describes the temperature change?

	place from which the particles escape	temperature of remaining liquid
A	body of the liquid	decreases
B	body of the liquid	increases
C	surface of the liquid	decreases
D	surface of the liquid	increases

52 A solid is heated causing it to expand.

What effect does this have on its mass and on its density?

	mass	density
A	decreases	decreases
B	decreases	stays constant
C	stays constant	decreases
D	stays constant	stays constant

53 What are the correct terms for each change of state?

	liquid to solid	liquid to gas
A	solidification	condensation
B	melting	condensation
C	solidification	evaporation
D	melting	evaporation

54 The temperature of the water at the bottom of a waterfall is greater than the temperature of the water at the top.

The energy in the gravitational potential store of the water at the top is transferred to the thermal store at the bottom.

The specific heat capacity of water is 4200 J / (kg °C).

What is the temperature difference for a waterfall of height 21 m? **(extended only)**

A 0.0050 °C **B** 0.049 °C **C** 20 °C **D** 200 °C

55 An ice cube is placed in a beaker and is heated.

The ice melts to form water, which evaporates at first and then boils.

The steam condenses on a cold window in the room.

Which process involves a transfer of energy from the ice, water or steam to the surroundings?

A melting

B evaporating

C boiling

D condensing

56 Two samples of the same material have the same mass but different surface areas.

Each sample is heated to the same temperature and then left to cool to room temperature.

Each sample is allowed to cool to the same final temperature.

Which row correctly compares the decrease in internal energy and the initial rate of cooling for each sample?

	decrease in internal energy	initial rate of cooling
A	X loses more internal energy than Y	X cools down faster than Y
B	Y loses more internal energy than X	Y cools down faster than X
C	X and Y lose the same quantity of energy	X cools down faster than Y
D	X and Y lose the same quantity of energy	Y cools down faster than X

57 On a warm day, a carton of fresh milk is covered with a wet cloth.

Why does this help to reduce the temperature of the milk?

A Some water evaporates from the cloth so the remaining water becomes cooler.

B The water has a very high specific heat capacity.

C The water insulates the milk from the warm air around it.

D Water is always colder than the air around it.

58 A chef heats some water in a pan on a hotplate. **(extended only)**

The temperature of the water rises by 10 °C in time *t*.

She then puts the same volume of oil in an identical pan on the same hotplate.

The specific heat capacity of water is 2.5 times that of oil and water is 1.1 times denser than oil.

What is the time for the temperature of the oil to rise by 10 °C?

A 0.36*t* **B** 0.44*t* **C** 2.3*t* **D** 2.8*t*

59 Liquid evaporates from a beaker.

What happens to the temperature of the remaining liquid and how does this temperature change affect the rate of evaporation?

	temperature	rate of evaporation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

60 Thermal energy ΔE is supplied to an object of mass m which does not change its state during the heating process. The temperature of the object rises by ΔT.

What is the specific heat capacity of the object? **(extended only)**

A $\frac{\Delta E}{m\Delta T}$ **B** $\frac{m\Delta T}{\Delta E}$ **C** $\frac{\Delta E\Delta T}{m}$ **D** $\frac{\Delta Em}{\Delta T}$

61 Which row correctly describes boiling and evaporation of water? **(extended only)**

	boiling	evaporation
A	bubbles seen	occurs at surface only
B	bubbles seen	occurs throughout the water
C	no bubbles	occurs at surface only
D	no bubbles	occurs throughout the water

62 Four students are asked to state and explain the relative magnitudes of the thermal expansion of solids and gases.

Which student is correct? **(extended only)**

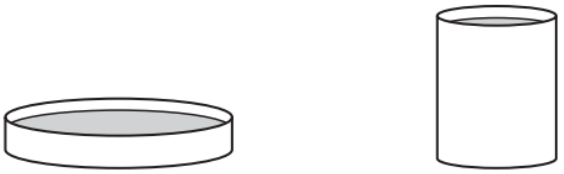
A Gases expand more than solids because the molecules in a gas are in random motion.

B Gases expand more than solids because the attractive forces between molecules are much weaker in gases.

C Solids expand more than gases because the molecules are closer together in solids.

D Solids expand more than gases because the molecules in a solid are in a regular pattern.

63 Two open containers are filled with water at room temperature. The containers have different shapes.



container 1 container 2

From which container does the water evaporate at the greater rate and how can the rate of evaporation be increased?

	container with the greater rate of evaporation	how the rate of evaporation can be increased
A	1	decrease the water temperature
B	1	increase the water temperature
C	2	decrease the water temperature
D	2	increase the water temperature

64 A glass contains an iced drink on a warm and humid day. Water starts to form on the outside of the glass.

What is the name of the effect by which the water forms?

A condensation

B conduction

C convection

D evaporation

65 An aluminium block has a mass of 200 g. **(extended only)**

The specific heat capacity of aluminium is 900 J / (kg °C).

How much energy is needed to increase the temperature of the block from 20 °C to 110 °C?

A 2.0 J **B** 2000 J **C** 16 200 J **D** 16 200 000 J

66 A block of metal absorbs 2000 J of thermal energy. **(extended only)**

The temperature of the block rises from 10 °C to 20 °C.

The mass of the block is 2.0 kg.

What is the specific heat capacity of the metal?

A 50 J / (kg °C) **B** 100 J / (kg °C) **C** 200 J / (kg °C) **D** 400 J / (kg °C)

67 Which statement about boiling and evaporation is correct?

A Boiling requires a supply of thermal energy but evaporation does not.

B Evaporation takes place at the surface of a liquid but boiling takes place throughout the liquid.

C When water boils in a kettle, its temperature decreases.

D When water evaporates, its temperature increases.

68 A block of aluminium of mass 2.0 kg has an initial temperature of 20 °C. It absorbs 7300 J of thermal energy.

The specific heat capacity of aluminium is 913 J / (kg °C).

What is the final temperature of the aluminium block? **(extended only)**

A 4.0 °C **B** 8.0 °C **C** 24 °C **D** 28 °C

69 The specific heat capacity of solid P is greater than that of solid Q. **(extended only)**

What does this statement mean?

A Less energy is needed to raise the temperature by 1 °C of unit mass of solid P than unit mass of solid Q.

B Less energy is needed to melt unit mass of solid P than unit mass of solid Q.

C More energy is needed to raise the temperature by 1 °C of unit mass of solid P than unit mass of solid Q.

D More energy is needed to melt unit mass of solid P than unit mass of solid Q.

70 A student splashes water on to her face. Here are three statements about the effects.

P The water uses energy to evaporate.

Q The water gains energy from the student.

R The face of the student cools.

Which statements are correct?

A P and Q only **B** P and R only **C** Q and R only **D** P, Q and R

71 Four blocks are made from different metals. Each block is heated for five minutes with an identical heater.

Assume there is no energy loss from the blocks.

The table gives the masses of the blocks and the temperature rises.

Which metal has the highest specific heat capacity? **(extended only)**

	mass of block / kg	temperature rise / °C
A	2.0	5.0
B	2.0	9.0
C	4.0	5.0
D	4.0	9.0

72 Water in a beaker evaporates when left on a bench for a period of time.

Which three factors all affect the rate of evaporation of the water?

A wind speed, surface area, temperature

B wind speed, temperature, volume

C wind speed, surface area, volume

D surface area, temperature, volume

73 A liquid turns into a gas. This occurs only at one particular temperature, and the change happens throughout the liquid.

What is this process called?

A boiling

B condensation

C evaporation

D fusion

74 An object of mass 800 g and specific heat capacity 250 J/(kg °C) is heated. It absorbs 5300 J of energy.

What is the increase in temperature of the object? **(extended only)**

A 0.027 °C **B** 17 °C **C** 27 °C **D** 17 000 °C

75 A block of iron of mass M is heated and gains 10 kJ of internal energy. The temperature of the block rises by θ °C.

A second block of iron of mass $2M$ is heated and gains 5.0 kJ of internal energy.

What is the temperature rise of the second block in °C? **(extended only)**

A $\frac{\theta}{4}$ **B** $\frac{\theta}{2}$ **C** 2θ **D** 4θ

76 Which statements about boiling and about evaporation are both correct?

	boiling	evaporation
A	takes place only at the surface	takes place only at the surface
B	takes place only at the surface	takes place throughout the liquid
C	takes place throughout the liquid	takes place only at the surface
D	takes place throughout the liquid	takes place throughout the liquid

77 In an experiment, an object is heated. **(extended only)**

The data from the experiment is shown.

- The energy transferred to the object is 3.0 kJ.
- The mass of the object is 2.0 kg.
- The rise in temperature of the object is 10 °C.
- The specific heat capacity of the object is 150 J / (kg °C).

What is the thermal capacity of the object?

A 30 J / °C **B** 300 J / °C **C** 3000 J / °C **D** 9000 J / °C

78 A 1 kg block of aluminium requires more thermal energy to raise its temperature by 1 °C than a 1 kg block of copper requires.

Why is this? **(extended only)**

A Aluminium is a better conductor of thermal energy than copper.

B Aluminium is a poorer conductor of thermal energy than copper.

C Aluminium has a higher specific heat capacity than copper.

D Aluminium has a lower specific heat capacity than copper.

79 A hole is drilled in a metal plate.

What happens to the length of the plate and to the diameter of the hole when the plate is cooled?

	length of plate	diameter of hole
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases