

PHYSICS



EXAM QUESTION PACK

P7.2 POWER AND EFFICIENCY

SCORE

/194

PERCENTAGE

%

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Gateway Physics A (9-1)

Power and efficiency

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate
forename

Candidate
surname

Centre number

Candidate number

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **194**.
- The total number of marks may take into account some 'either/or' question choices.

1 Which wall would allow the **most** heat transfer through the wall?

- A **Thick** wall made from a material with **high** thermal conductivity.
- B **Thick** wall made from a material with **low** thermal conductivity.
- C **Thin** wall made from a material with **high** thermal conductivity.
- D **Thin** wall made from a material with **low** thermal conductivity.

Your answer

[1]

2 A radio transfers 30 J of potential energy to 27J of useful energy.

What is the efficiency and energy loss for the radio?

	Efficiency	Energy loss
A	10%	3J
B	10%	27J
C	90%	3J
D	90%	27J

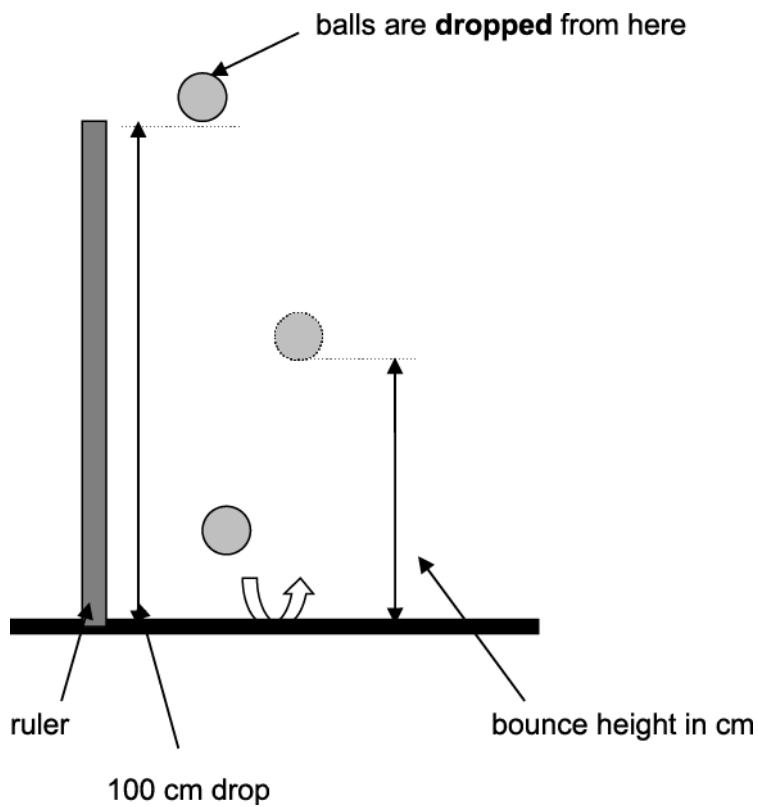
Your answer

[1]

3(a) Kate investigates how well different balls bounce.

She drops different balls from the same height and measures the height the balls bounce.

She repeats the experiment 3 times for each ball.



Her results are shown in the table.

Ball	Drop height (cm)	1 st reading bounce height (cm)	2 nd reading bounce height (cm)	3 rd reading bounce height (cm)	Mean bounce height (cm)
Red	100	75	77	73	75
Blue	100	61	62	60	61
Green	100	60	31	58	
White	100	84	86	85	85
Yellow	100	26	24		26

Calculate the **mean** bounce height for the **green** ball.

[1]

answer:----- cm

- (b) Kate missed one result for the **yellow** ball.

Calculate the **missing** result for the **yellow** ball.

answer: ----- cm

[1]

- (c) Evaluate the reliability of the results

Suggest how she could have improved her experiment.

----- [3]

- (d)

- (i) Kate suggests that 15% of the ball's initial energy was not transferred usefully. Use calculations to show that this is correct and suggest where the energy was transferred to.

----- [2]

- (ii) How could the efficiency of the ball be improved?

----- [1]

- 4 A radio transfers 30 J of potential energy to 27 J of useful energy.

What is the efficiency and energy loss for the radio?

	efficiency	energy loss
A	10%	3 J
B	10%	27 J
C	90%	3 J
D	90%	27 J

Your answer

[1]

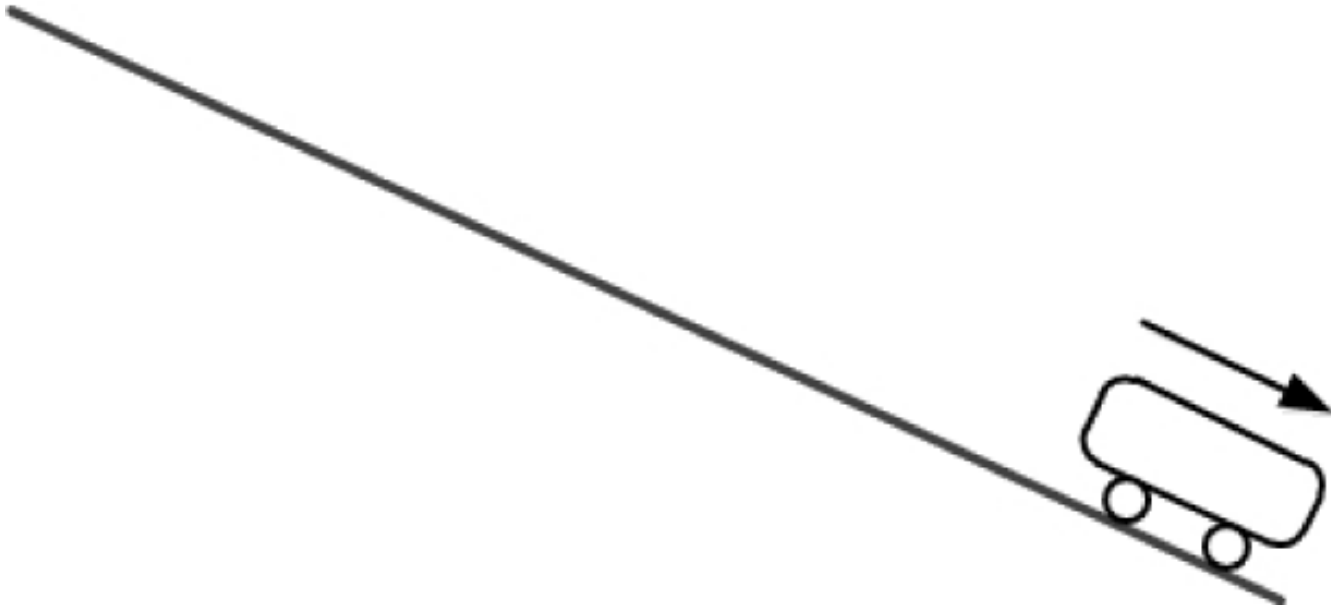
5 Which row **increases** the efficiency of a machine?

	increase energy losses due to friction	increase the work output without changing the work input
A	Yes	yes
B	Yes	no
C	No	no
D	No	yes

Your answer

[1]

6 A car rolls down a slope.



The energy at the bottom of the slope is lower than expected.

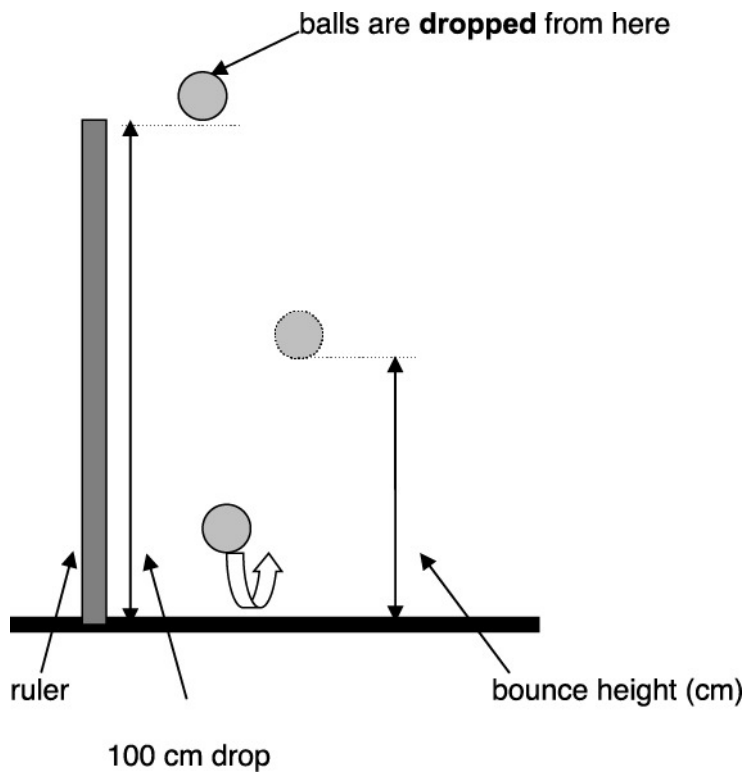
Suggest **two** ways to improve the efficiency of the roller coaster car.

[2]

7(a) Kate investigates how well different balls bounce.

She drops different balls from the same height and measures the height the balls bounce.

She repeats the experiment 3 times for each ball.



Her results are shown in the table.

Ball	Drop height (cm)	1 st reading bounce height (cm)	2 nd reading bounce height (cm)	3 rd reading bounce height (cm)	Mean bounce height (cm)
blue	100	61	62	60	61
green	100	60	31	59	50
white	100	84	86	85	85
yellow	100	26	24		26

Kate missed one result for the **yellow** ball.

Calculate the **missing** result.

answer: _____ cm

[1]

(b) Josh does an experiment with bouncing balls.

He does his experiment with a drop height of 200 cm.

One ball bounces 100 cm.

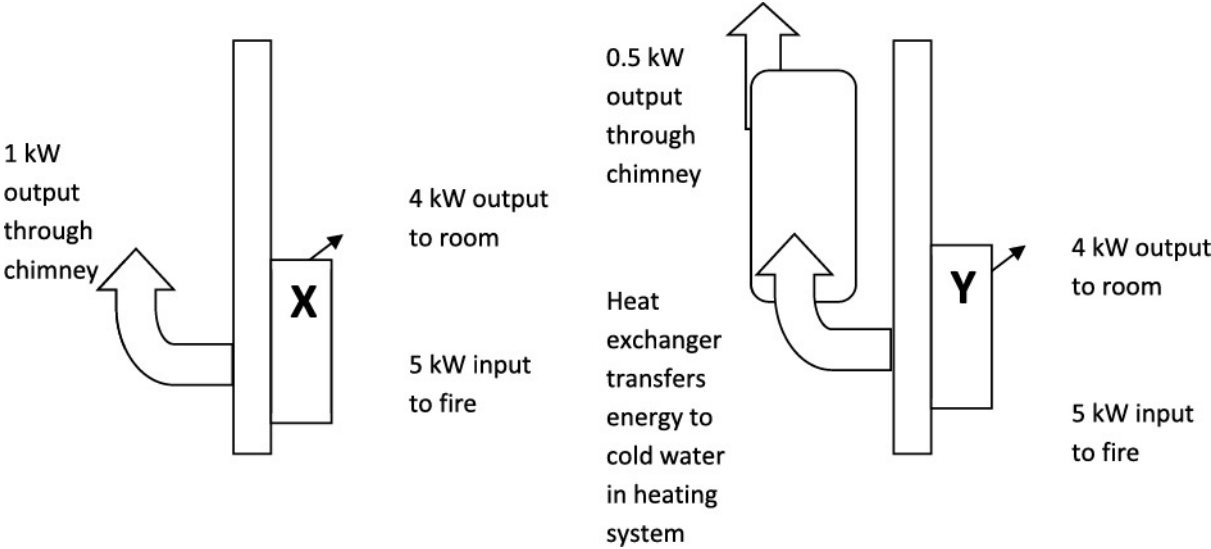
Josh says that this ball is a better bouncer than any of Kate's.

Use the data and ideas about efficiency to explain why Josh is incorrect.

[2]

The radiators have different power ratings.

(b) Alex has two fires in her home, X and Y shown in the diagrams below.



Why does Fire Y helps save money on the energy bills for her home?

Use calculations of efficiency in your answer.

[4]

9 Cars and lorries have different brakes.

Brakes absorb the energy of the vehicle before it comes to rest.

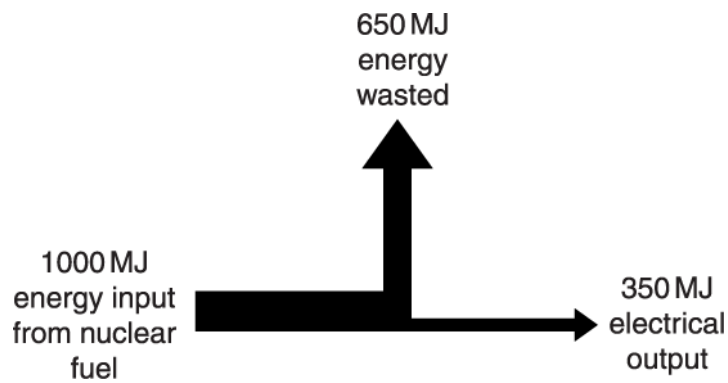
The brakes on lorries have larger brake discs and brake pads than cars.

Brakes are designed for increased air flow.

Explain why this is more important for lorries than cars.

[4]

10 Look at the diagram. It shows the amount of energy used and wasted in a nuclear power station.



- (i) Compare the energy input and all of the energy outputs for the nuclear power station. Suggest how the energy is wasted.

----- [2]

- (ii) Calculate the efficiency of this power station.

answer

----- [2]

11(a) This question is about insulation in houses.

Look at the diagrams of these two designs of wall that are used in building houses.

(b) Look at the advert about double glazing.

Buy Evercosy double glazing.

Fitting double glazing to your house will save up to 18% on your energy costs.

Spend a little and save a lot. Choose Evercosy.

Simon has double glazing fitted in his house. He thinks it saves him money.
Look at the data.

Year	Double glazing	Annual energy cost in £
2009	none	1200
2010	none	1040
2011	none	1010
2012	fitted	950
2013	fitted	1020
2014	fitted	790

Before he fitted double glazing, Simon's average annual energy cost was £1083.

With an 18% saving the average annual energy cost should be £888.
How do Simon's actual annual energy costs from 2012 onwards compare to this figure?

Suggest reasons for this difference.

[3]

12 Ivy wants to insulate her house.

Look at the information on different types of house insulation.

Type of insulation	Cost to fit insulation in £	Money saved each year in heating bills in £
Cavity wall insulation	840	210
Double glazing	4000	160
Draught proofing	120	72
Loft insulation	360	120

Ivy decides against fitting double glazing.

One reason is because it costs a lot to fit.

Use the information in the table to suggest other reasons why she has made this decision.

Do a calculation to explain your answer.

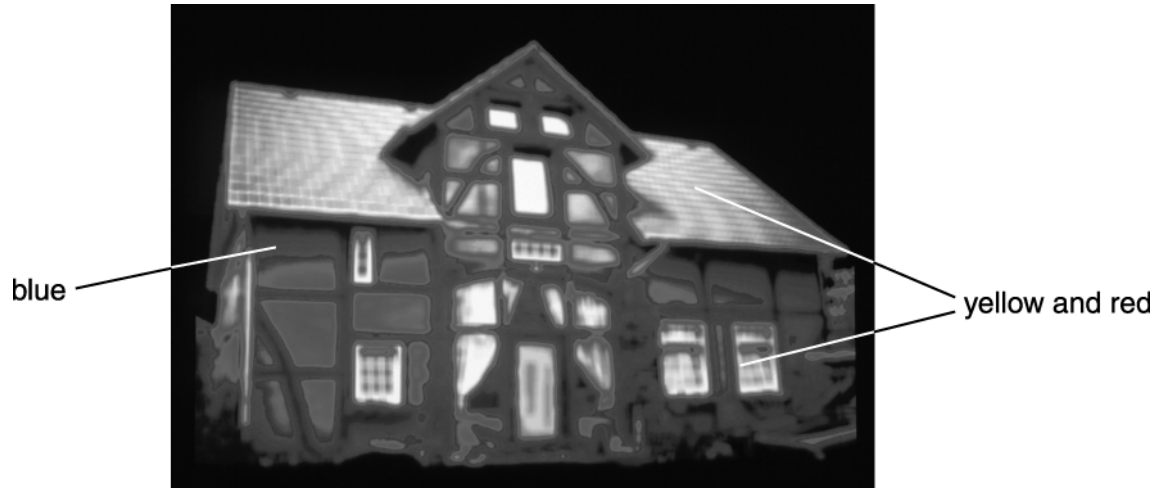
-----[2]

13 Ivy has an energy survey done on her house.

An engineer takes a thermogram photo of Ivy's house on a cold day.

The thermogram shows where heat escapes from her house.

Look at the black and white copy of the thermogram.



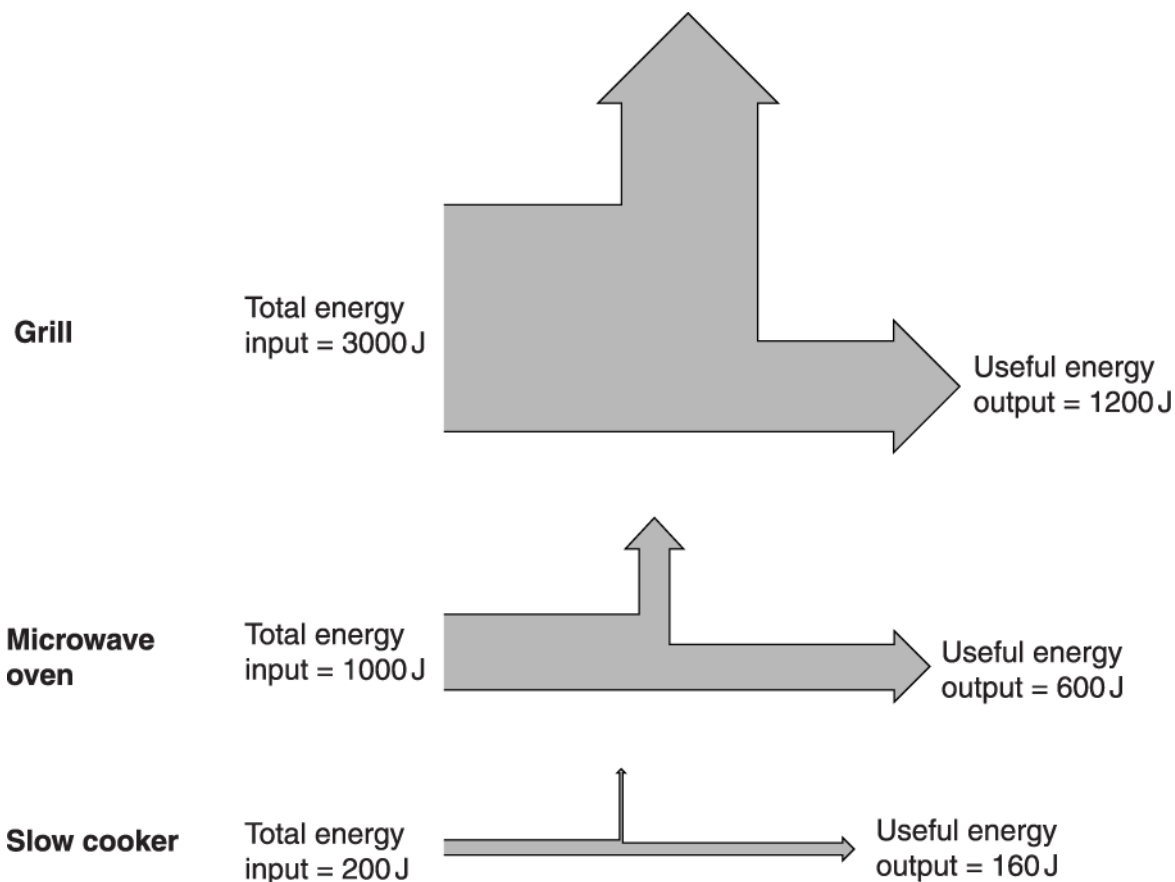
Explain what useful information Ivy can gain from the different colours on this thermogram.

[2]

14(a) Radhika has many appliances in her kitchen.

She compares the efficiency of the appliances by looking at these Sankey diagrams.

Each diagram shows the energy transferred in 1 second.



Look at the Sankey diagram for the grill.

Calculate the wasted energy for the grill.

Answer J

[1]

(b) Calculate the efficiency of the microwave oven.

Answer

[2]

(c) The slow cooker takes the **longest time** to cook food.

However, it is the **most efficient**.

Use the data to explain both these statements.

[3]

15(a) Ivy wants to insulate her house.

Look at the information on different types of house insulation.

Type of insulation	Cost to fit insulation in £	Money saved each year in heating bills in £
Cavity wall insulation	840	210
Double glazing	4000	160
Draught proofing	120	72
Loft insulation	360	120

Ivy wants to fit all four types of insulation in her house.

(i) How much money will Ivy save in heating bills each year if she fits all four types of insulation?

answer -----

[1]

(ii) Ivy only has £4100 to spend on insulating her house.

Is £4100 enough for her to fit **all four** types of insulation?

Do a calculation to explain your answer.

-----[1]

(iii) Ivy decides against fitting double glazing.

One reason is because it costs a lot to fit.

Use the information in the table to suggest other reasons why she has made this decision.

Do a calculation to explain your answer.

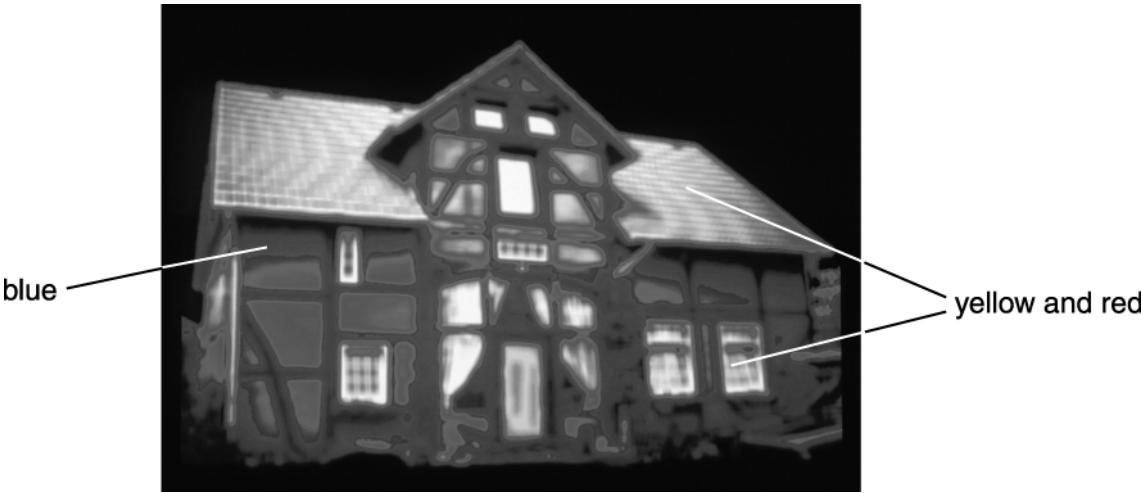
-----[2]

(b) Ivy has an energy survey done on her house.

An engineer takes a thermogram photo to show where heat escapes from Ivy's house.

He chooses a cold day to get the best results.

Look at the black and white copy of the thermogram.



Explain in detail how Ivy can use the thermogram to show where heat escapes from her house and suggest why a cold day gives the best results.



The quality of written communication will be assessed in your answer to this question.

[6]

*Buy **Evercosy** double glazing.*

Fitting double glazing to your house will save up to 18% on your energy costs.

*Spend a little and save a lot.
Choose Evercosy.*

Simon has double glazing fitted in his house. He thinks it saves him money.
Look at the data.

Year	Double glazing	Annual energy cost in £
2009	none	1200
2010	none	1040
2011	none	1010
2012	fitted	950
2013	fitted	1020
2014	fitted	790

Before he fitted double glazing, Simon's average annual energy cost was £1083.

With an 18% saving the average annual energy cost should be £888.

How do Simon's actual annual energy costs from 2012 onwards compare to this figure?

Suggest reasons for this difference.

[3]

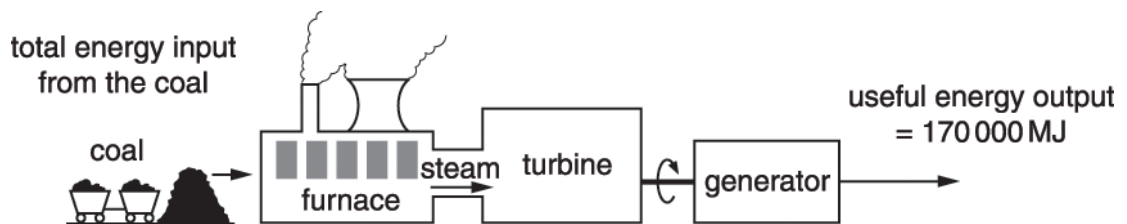
- 17 A coal power station has an input power of 500 MW.

Power generator	% Efficiency
Wind turbine farm	30
Coal power station	34
Nuclear power station	35
Oil power station	32
Gas power station	45

Using information in the table, calculate the energy in MJ wasted each **minute** in this power station.

----- [3]

- 18 Electricity is generated in power stations.



The efficiency of this power station is 34%.

Calculate the total energy input from the coal.

answer ----- MJ

[1]

19(a) Allan wants to reduce energy losses from his house.

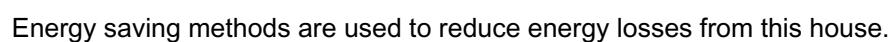
He asks an energy adviser for help.

The adviser uses a camera to produce a thermogram of the house.

Explain how the thermogram can be used to compare how much heat energy is lost from different parts of the house.

[2]

It shows where some of the energy losses happen.



	Energy saving method	Cost to fit in £	Annual saving on energy bills in £	Payback time in years
A	double glazed windows	4800	100	
B	loft (roof) insulation	270	45	
C	draught-proofing	90	30	
D	cavity wall insulation	240	120	

Complete the table and use the information to explain why C **and** D are the best methods for Allan to install.

[3]

- (c) The energy adviser also suggests that Allan replaces his old central heating boiler.

The Sankey diagram shows energy data for Allan's boiler.



- (i) Calculate the efficiency of Allan's boiler.

Give your answer as a percentage.

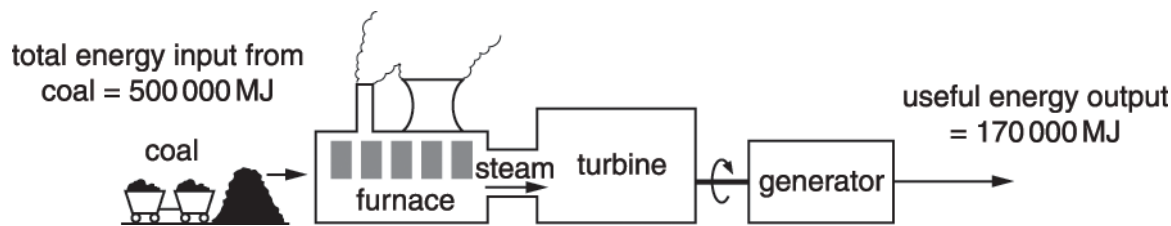
efficiency ----- %

[3]

- (ii) Allan thinks that some of the energy completely disappears.

How could the adviser use the Sankey diagram to explain that this was **not** scientifically correct?

[1]



Calculate the efficiency of this power station.

efficiency -----

[2]

21(a) Allan wants to reduce energy losses from his house.

He asks an energy adviser for help.

The adviser uses a thermal imaging camera to produce a photograph of the house.

It is used to indicate where heat energy is lost from the house.

The adviser writes a report for Allan.

He includes a black and white photocopy of the original photograph in his report.



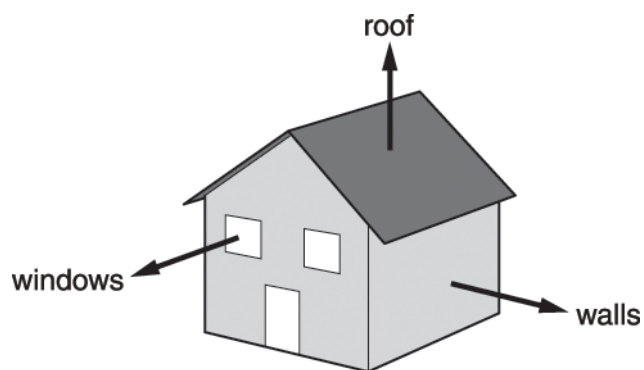
Complete the sentences about the **original** photograph.

The temperature is represented by different _____ .

This type of photograph is known as a _____ .

[2]

- (b) The adviser's report has a diagram which shows where some of the energy is lost.



Energy saving methods are used to reduce energy losses from houses.

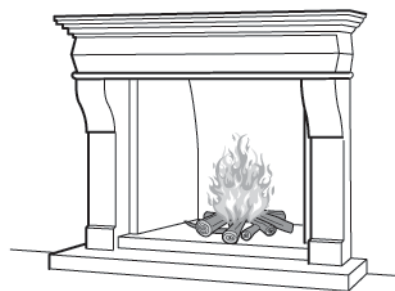
Many of these methods use air to reduce energy loss.

Describe the energy saving methods that could reduce energy losses from Allan's house using air. Explain how air is important.

[3]



heater A – in front of the wall



heater B – built into the wall

energy input from gas per second = 3 kJ

heat output to room per second = 2.4 kJ

energy input from gas per second = 4 kJ

heat output to room per second = 2 kJ

Compare the **efficiency** of the two heaters and explain why they have **different** heat outputs to the room.



The quality of written communication will be assessed in your answer to this question.

[6]

[6]

23 An energy adviser suggests that Allan replaces his old central heating boiler.

The Sankey diagram shows energy data for Allan's boiler.



(i) Calculate the efficiency of Allan's boiler.

Give your answer as a percentage.

efficiency ----- %

[3]

(ii) The adviser tells Allan that his boiler is in a low efficiency band.

Band	Efficiency range
A	90% and above
B	86% – 90%
C	82% – 86%
D	78% – 82%
E	74% – 78%
F	70% – 74%
G	below 70%

Is the energy adviser correct?

answer _____

Explain your answer.

----- [1]

24(a) Grace researches methods of loft insulation for her house.

Look at the information she finds.

Insulating material	Recommended thickness of insulating material in mm
Phenolic foam	78
Rockwool	128
Polyurethane	76
Polystyrene	124
Spray foam	74
Sheep's wool	132

Suggest which material is the best insulator and explain your answer.

----- [2]

(b) Grace thinks that she can improve her loft insulation.

She uses a layer of **shiny aluminium foil** under the insulating material.

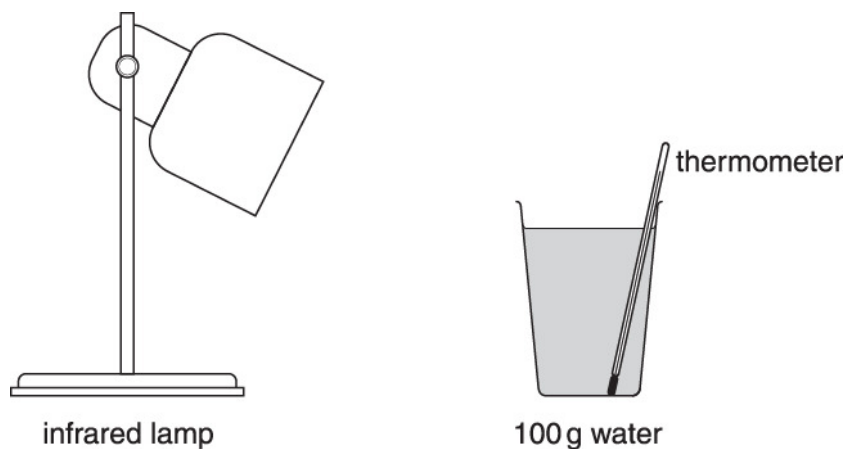
Explain how shiny aluminium foil can **improve** her loft insulation.

----- [1]

25 Alex wants to keep her drinks cool on a hot day.

She does this experiment to find out which cup is best to use.

Look at the diagram.



Alex uses the lamp to warm up 100 g of cold water in a cup.

She places the cup 20 cm from the lamp.

Alex measures the temperature of the water after 1 hour.

She repeats this experiment with three different cups.

Look at her results.

Cup	Material	Surface of cup	Starting temperature in °C	Finishing temperature in °C	Temperature rise in °C
A	polystyrene	shiny	15	23	
B	polystyrene	black	15	29	
C	expanded polystyrene (contains air bubbles)	shiny	15	17	
D	expanded polystyrene (contains air bubbles)	black	15	20	

Use information about the material and surface of the cups to explain your answer.



The quality of written communication will be assessed in your answer to this question.

[6]

26(a) Microwave ovens are used to heat food.

Chris looks at information about three microwave ovens.

Microwave oven	Energy input per second in joules	Energy absorbed by food each second in joules	Heating efficiency of the oven
Thermo-wave	1200	600	
Micro-fast	1400	700	
Quick-cook	1000	800	

Calculate the heating efficiency of the Quick-cook oven.

[2]

- (b) The Thermo-wave and Micro-fast ovens have the **same** heating efficiency.
How does the information in the table show this?

[1]

- (c) Chris wants to compare the three ovens.
He wants to know which oven heats food the fastest.

Describe an experiment Chris could do to find this out.

[3]

27 Engineers try to make motors as efficient as possible by reducing waste energy through heating.

Look at the information about three new motors.

	Efficiency of motor at different currents		
Name of motor	2 amps	4 amps	6 amps
Duty	93%	92%	87%
Effortless	96%	93%	72%
Factor	95%	94%	87%

The engineer wants to use the motor with a 5 amp current.

Which motor should the engineer use?

Explain your reasons for choosing this motor.

[2]

28 Steve investigates different types of insulation.

Look at the table of his results.

Type of insulation	Initial cost in £	Yearly saving in £
double glazing	9000	90
loft insulation	300	150
cavity wall insulation	450	150
draught-proofing	20	40

Steve wants to install insulation in his home.

Use the information in the table to suggest which type of insulation Steve should install first.

Include calculations and an explanation in your answer.

[3]

30 A power station has an efficiency of 30% and an energy input of 1 500 000 J.

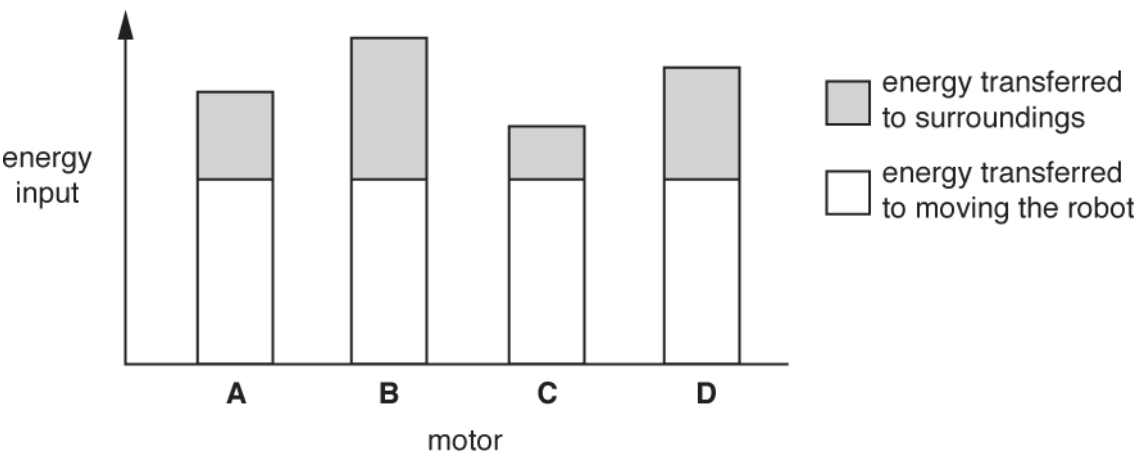
Calculate the wasted energy in the power station.

Answer ----- J

[3]

31 A robot has a motor to make it move.

Kate finds information about motors A, B, C and D.



Kate says 'the best motor to use is C'.

Explain why she is correct.

[2]

32 A power station with an energy input of 100 MJ has a useful energy output of 30 MJ.

Calculate the efficiency of this power station.

Answer -----

[2]

33 A gas fire, used to heat a room, has an input energy transfer of 180 000 J per minute.

The fire has an efficiency of 0.8.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Calculate the useful output energy transfer per minute.

A 600 J

B 2400 J

C 36 000 J

D 144 000 J

Your answer

[1]

34 A pump lifts 500 kg of water to a water tank at the top of a building.

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

Use the equation: Potential energy = Mass $\times$ Height $\times$ Gravitational field strength

Calculate the height of the water tank.

A 4.8 m

B 48 m

C 240 m

D 480 m

Your answer

[1]

35 A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

- (i) The domestic wind turbine has an electrical resistance of $23\ \Omega$.

It generates a current of 11 A on a windy day.

Calculate the power output in kW of the turbine on this day.

Answer = _____ kW [4]

- () Suggest why the manufacturer gives a range for the power rating of the wind turbine.

[1]

- (i) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

[1]

36 A vehicle has an input power from fuel of 20 kW and a useful output power of 6 kW.

Calculate the power it wastes.

- A 3 kW
- B 6 kW
- C 14 kW
- D 20 kW

Your answer

[1]

37(a) Look at the information about different electric motors.

Electric motor	Energy input per hour (J)	Useful energy output per hour (J)	Energy 'wasted' per hour (J)
A	72 000	60 000	
B	54 000	36 000	
C	18 000		3 000
D		48 000	12 000
E	54 000	48 000	

(i) Calculate the energy input per hour in J for electric motor D.

Answer = ----- J [2]

(ii) Which electric motor has the **lowest** 'wasted' energy in one hour?

----- [1]

(iii) Which electric motor has the **highest** 'wasted' energy in one hour?

----- [1]

(iv) Describe how energy is 'wasted' in an electric motor.

----- [1]

(v) Suggest how this 'wasted' energy can be reduced in an electric motor.

----- [1]

(b) Calculate the % efficiency of electric motor E.

Use the equation: Efficiency = Useful output energy transfer / Input energy transfer

Give your answer to 2 significant figures.

Answer = ----- % [2]

38 A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

- (i) The domestic wind turbine has an electrical resistance of $23\ \Omega$.

It generates a current of 11 A on a windy day.

Calculate the **power** output in kW of the turbine on this day.

Answer = ----- kW [4]

- (ii) Suggest why the manufacturer gives a range for the power rating of the wind turbine.

----- [1]

- (iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

----- [1]

39 A boiler has an input power of 12 kW from the gas it burns.

Its efficiency is 0.75.

Which row in the table shows the correct values for this boiler?

	Useful output power (kW)	Wasted output power (kW)
A	3	9
B	8	4
C	9	6
D	9	3

Your answer

[1]

40 A TV works with a 12.0 V battery. It has a current of 3.19 A.

Calculate the power rating of the TV.

Power = ... W [3]

41 A boiler has an input energy of 720 kJ from the gas it burns.

It transfers 540 kJ of useful energy to the home.

What is the efficiency of the boiler?

Use the equation: $\text{efficiency} = \text{useful output energy transfer} \div \text{total input energy transfer}$

A 0.12

B 0.75

C 0.90

D 1.33

Your answer

[1]

42(a) A student investigates how the thickness of insulation affects the cooling of a cup of tea.

Fig. 16.1 is a diagram of her apparatus.

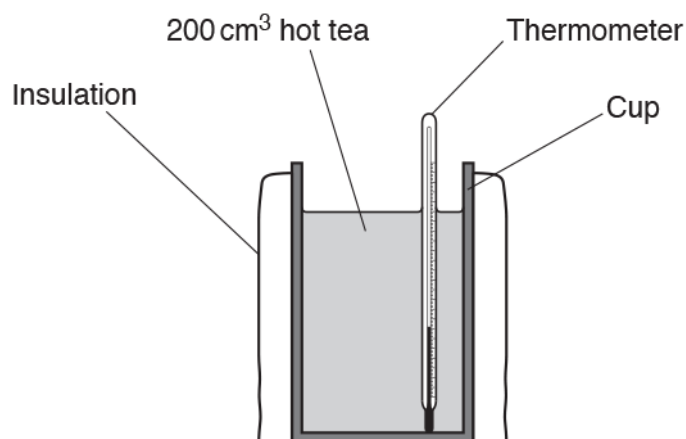


Fig. 16.1

The student wraps a layer of insulation around a cup containing 200 cm³ of hot tea.

She measures the temperature of the tea at the start of the experiment and after 10 minutes.

She repeats the experiment with different thicknesses of the insulation.

Table 16.1 shows her results.

Thickness of the insulation (mm)	Temperature of tea (°C)		
	Start	End	Difference
2	90	65	25
4	88	66	22
6	91	72	19
8	89	73	16
10	98	84	14
12	100	60	

Table 16.1

- (i) Calculate the temperature difference when the thickness of insulation is 12 mm.

Temperature difference = ... °C [1]

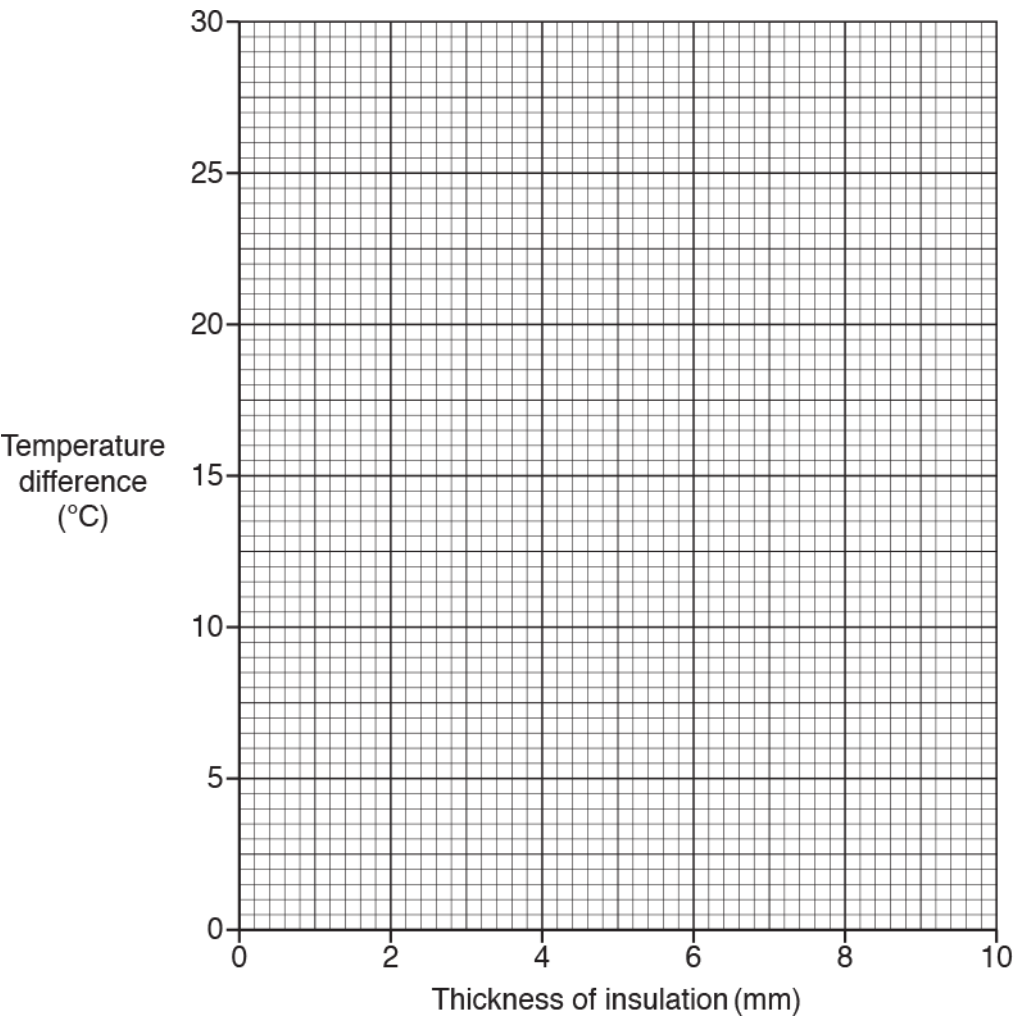
- (ii) The result when the thickness of the insulation is 12 mm is anomalous.

Suggest a reason why this result appears to be anomalous.

[1]

(b) Plot a graph of the results in **Table 16.1** and draw a line of best fit.

Ignore the anomalous result for 12 mm.



[2]

(c) Describe how the temperature difference is affected as the thickness of the insulation increases.

[1]

(d) Suggest how the thickness of the insulation affects the rate of cooling of the tea.

----- [1]

(e) This experiment could be improved.

Describe two **different** ways of improving the experiment.

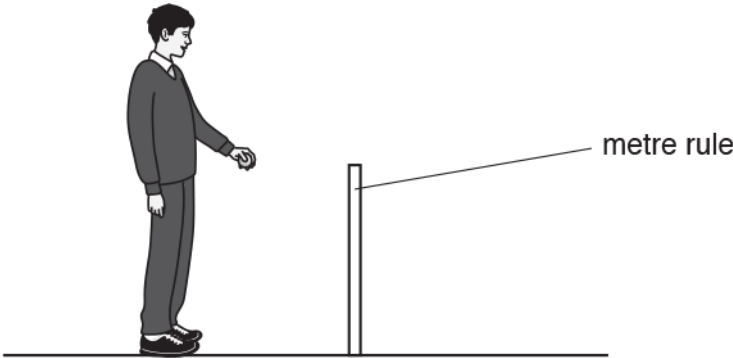
1 -----

2 -----

[2]

43(a) A student wants to investigate how a ball bounces.

He drops the ball from different heights and measures the bounce height each time.



He calculates the ratio bounce height / drop height.

The table shows his results.

Drop height (cm)	Bounce height (cm)	Bounce height / drop height
100	70	0.70
80	64	0.80
60	54	0.90
40	40	1.00
20		

The student predicts the ratio bounce height / drop height to be 1:1 when the drop height is 20 cm.

(i) Suggest why he has made this prediction.

[1]

(ii) Use ideas about energy to explain why this prediction cannot be correct.

[1]

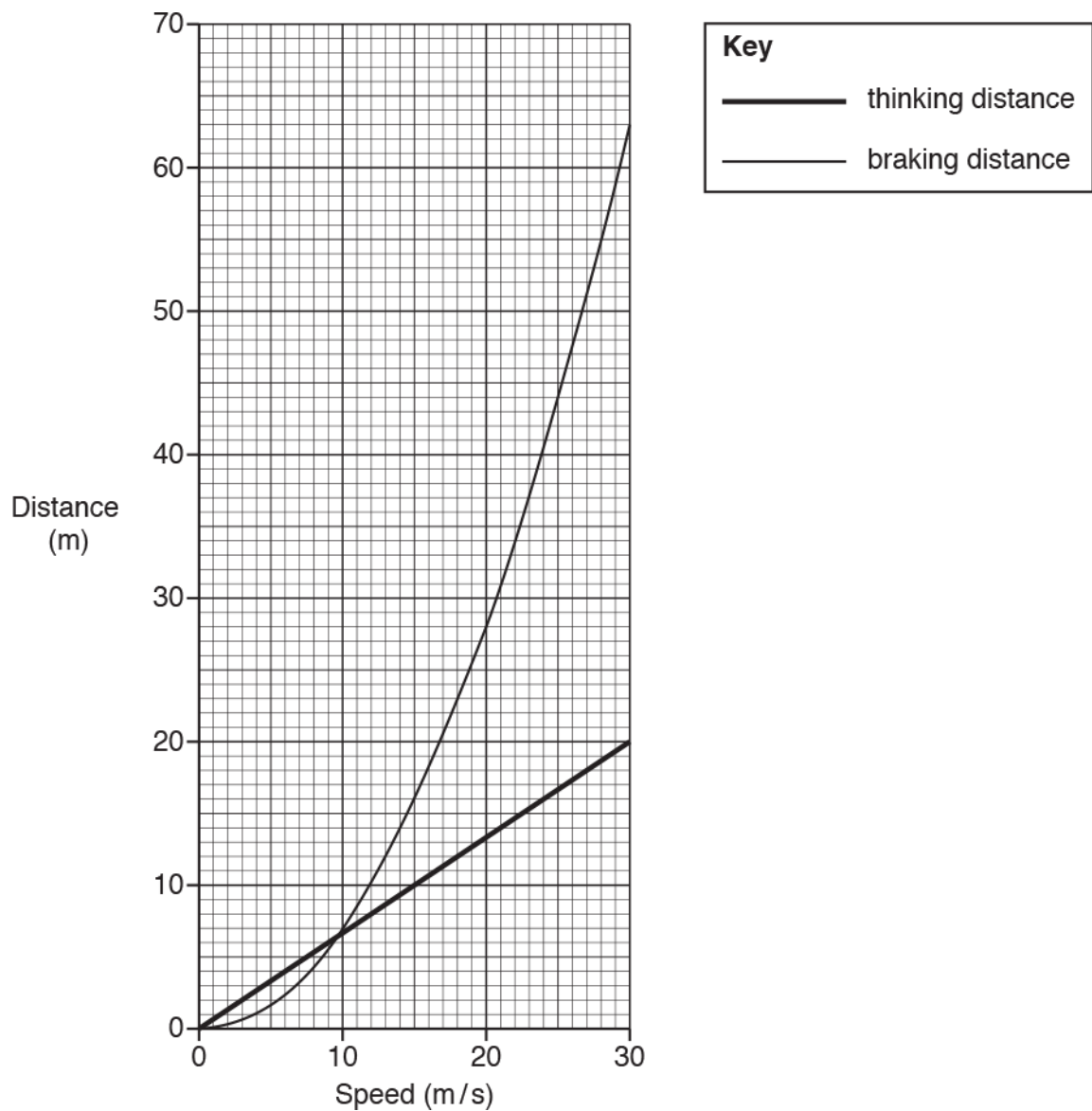
(b) Suggest **two** improvements to his experiment.

1 _____

2 _____

[2]

44 The graph shows thinking and braking distances for a car at different speeds.



Describe how **thinking distance** varies with increasing speed.

Use data from the graph in your answer.

[2]

45(a) A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

Describe a method she can use to do this investigation.

[3]

(b) Here are the results of one of her experiments.

Time (minutes)	Temperature of water (°C)
0	90
2	75
4	63
6	54
8	47
10	41
12	37

(i) Plot the results on the grid in Fig. 22.1.

Two of the points have been plotted for you.

[2]

(ii) Draw a line of best fit on your graph.

[1]

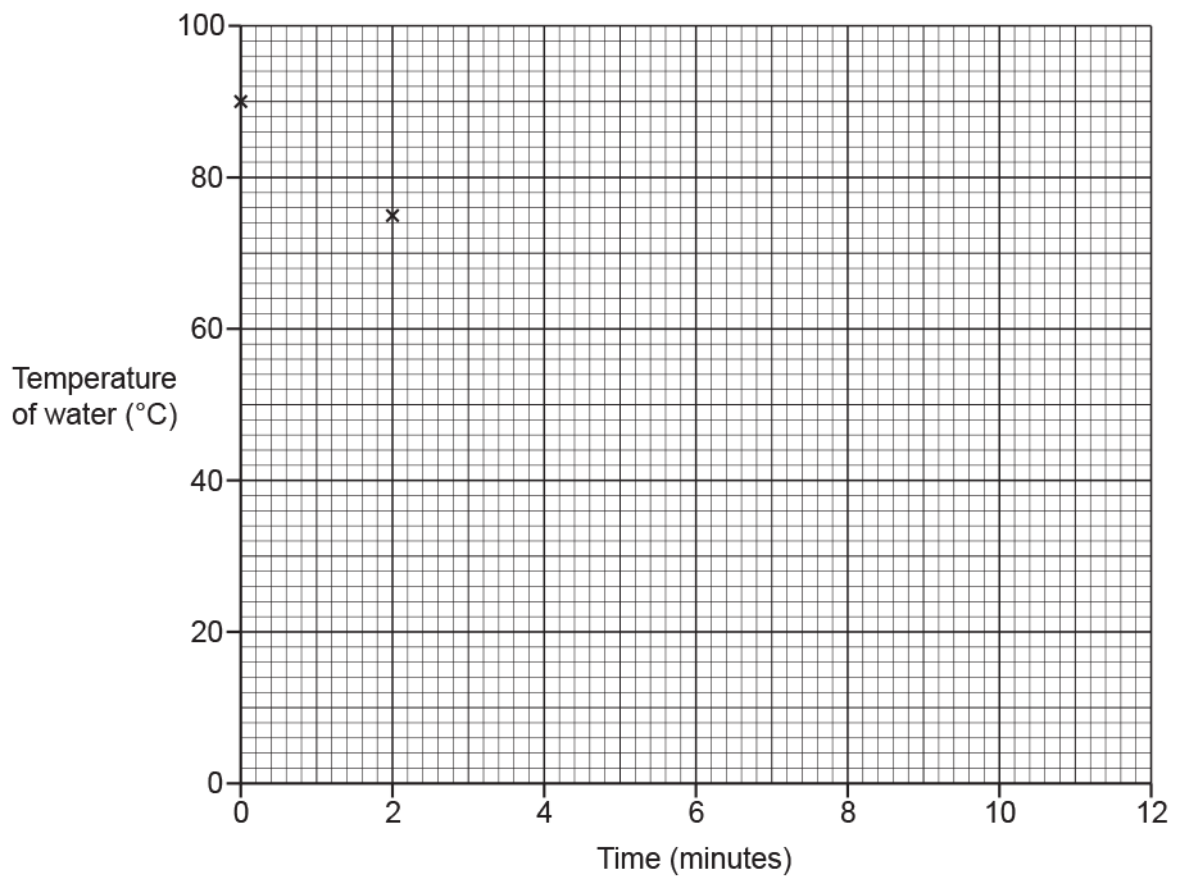


Fig. 22.1

- (iii) Describe how the temperature of the water changes with time.
Use data from the graph in Fig. 22.1 in your answer.

[2]

- (iv) The thickness of the cardboard box is doubled. Everything else stays the same.

Sketch a line on the graph in Fig. 22.1 to suggest what these new results may look like.
Label your line Z.

[1]

(v) Suggest **one** way to improve the investigation.

----- [1]

(c) Explain why the rate of cooling of a metal box is different to a cardboard box.
Assume the thickness of the walls is the same in both boxes.

----- [1]

46 A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

Describe a method she can use to do this investigation.

----- [7]

(i) **Table 21.1** gives some information about a kettle.

Energy transferred to the kettle	525 000 J
Mass of water	1.2 kg
Starting temperature of water	25 °C
Final temperature of water	100 °C
Specific heat capacity of water	4200 J / kg °C

Table 21.1

Calculate the efficiency of the kettle described in **Table 21.1**.

Give your answer as a percentage.

Use an equation from the data sheet.

Efficiency = ... % **[5]**

(ii) Explain why the efficiency of the kettle is less than 100%.

----- **[1]**

48 Explain why the rate of cooling of a metal box is different to a cardboard box.

Assume the thickness of the walls is the same in both boxes.

----- **[1]**

49 Water can be heated using a 12 V heater.

A transformer is used to change a 120 V supply into 12 V.

The current in the secondary coil is 9.0 A.

Calculate the current in the primary coil.

Use an equation from the data sheet.

Current = ... A [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	1	
2			C	1	
			Total	1	
3	a		59 (anomalous result should be left out of calculation) (1)	1	
	b		28 (1)	1	
	c		Green results unreliable / large variation / anomalous result (1) Should have repeated 31 (green) reading / other results (red, blue, white, yellow) are reliable (1) A sensible suggested improvement (1)	3	e.g. use camera to measure bounce heights (1)
	d	i	bounce height / drop height $\times 100\%$ = 85% useful, therefore 15% wasted. (1) transferred to heat and sound (1)	2	
		ii	If the bounce height was greater then the efficiency would be higher / ORA (1)	1	
			Total	8	
4			C	1	
			Total	1	
5			D	1	
			Total	1	
6			Reduce the friction between the car and track / lubrication (1) Make the shape of the car more streamlined to reduce drag (1)	2	
			Total	2	
7	a		28 (1)	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		(Josh's is only) 50% efficient / AW (1) And any one from: (Kate's) red is 76% efficient (1) Blue is 61% efficient (1) White is 85% efficient (1)	2	
			Total	3	
8	a		Energy for oil is 672 000 (J) (1) Energy for water is 1 680 000 (J) (1) Recall $P=E/t$ (1) Calculation to show: $672\,000 / 400 = 1680$ AND $1680000 / 1000 = 1680$ (1)	4	
	b		Half of the (previously) wasted power or energy / 0.5 kW is being used to heat water (1) Less energy needed from other sources to heat water (1) Fire X is $(4/5 \times 100\% =) 80\%$ efficient (1) Fire Y is $(4.5/5 \times 100\% =) 90\%$ efficient (1)	4	ALLOW some energy from fire now used to heat water scores (1)
			Total	8	
9			Lorry has more KE than a car at the same velocity (1) More absorption of energy by larger brake discs (1) Higher rate of dissipation of energy to surrounding air (1) Brakes less likely to overheat (1)	4	
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10		i	input = (total) output [1] idea that energy is wasted as heat [1]	2	allow answers in calculations e.g. 1000 (MJ) = 1000 (MJ) or 1000(MJ) = 650(MJ) + 350(MJ) [1] if no marks awarded then allow useful output is less than the input [1] <u>Examiner's Comments</u> This question was not answered well by many candidates. Examiners were looking for the idea, energy in = energy out, and that the wasted energy was usually heat.
		ii	0.35 or 35% [2] but if answer is incorrect or incomplete then: $\frac{350}{1000}$ [1] or $\frac{350 \times 100}{1000}$ [1]	2	allow 0.35% [1] allow 35 with no unit or incorrect unit [1] <u>Examiner's Comments</u> The majority of candidates performed the calculation correctly, but a significant number of candidates were penalised 1 mark for putting % after 0.35 or missing % after 35.
			Total	4	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
11	a	[Level 3] Sensible reference to: trapped air reducing convection, shiny foil reflecting radiation back into the building AND wall B is thicker than wall A so less conduction. ORA Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Sensible reference to trapped air as an insulator, AND shiny foil reflecting 'heat' back into the building OR wall B is thicker than wall A so less conduction. ORA Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Sensible reference to air or foam as an insulator OR shiny foil reflecting 'heat' OR wall B is thicker / better insulator than wall A. ORA Quality of written communication impedes communication of the science at this level. (1–2 marks) Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include: Level 3: - trapped air reduces convection - shiny foil reflects IR / radiation back into house Level 2: - trapped air is a good insulator / poor conductor - shiny foil reflects heat back into house Level 1: - air is a good insulator / poor conductor - air is trapped in B - foam is an insulator / prevents heat loss - shiny foil reflects heat - wall A is a better conductor than wall B ignore heat trapped Use the L1, L2, L3 annotations in Scoris; do not use ticks. <u>Examiner's Comments</u> Candidates were asked to explain why one wall lost less heat than the other wall. The question asked candidates to use ideas about conduction, convection and radiation, but very few candidates mentioned convection and, therefore, excluded themselves from the level 3 marks. This was targeted at level C and was a common question with the higher paper. Candidates could have gained full marks by a simple statement about each wall and the method of heat transfer eg air is a good insulator; trapped air reduces convection; shiny foil reflects IR back into the house; and wall B is thicker than wall A so less conduction.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		Correct comparison: cost higher than expected / less than 18% saving / saving is less [1] correct relevant calculation [1] some years are warmer / colder than others [1] the average may not be representative / average calculated over atypical years AW [1] differences in behaviour [1] cost of energy higher in later years [1]	3	allow 2012 and 2013 are higher / 2014 is lower [1] allow average is £920 allow any other correct use of data e.g. 2014 is £98 lower / £32 per year saving / £96 saved over 3 years [1] eg. only 15% lower / [2] not merely 'different weather' [0] allow examples e.g. 2009-11 may have been warmer than usual [1] allow examples e.g. Simon may have had windows opened more (often) / more people at home / more time at home / more heating used / more TV watched / settings on heating changed / alterations to house / different or extra appliances used / other or different insulation or energy collecting methods fitted [1] <u>Examiner's Comments</u> The first part of this question performed well with the majority of candidates making a relevant comparison of the costs. The second part proved more difficult for the majority of candidates. The examiners were looking for candidates to think of reasons as to why the heating bills were higher than expected. These include: increases in the cost of energy; extra appliances being used; cold weather requiring more heating; heat loss by leaving windows open etc.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12			payback time (of double glazing) is 25 (years) [2] long(est) payback time scores [1]	2	allow 25 on / at side of table clearly linked to double glazing [2] allow CWI saves £50 per year more than DG [2] allow takes a long time to payback / takes a long time to get your money back / AW [1] allow other correct payback calculations to help prove point: eg. CWI 4 years or DP 120/72 (1.67) or LI 3 years [1] allow does not save as much money per year as cavity wall insulation [1] ignore comparisons of the 'cost to fit' Examiner's Comments This question on payback time and house insulation discriminated well. This was very well answered with 25-years calculated for the payback time being commonplace. It was a common question with the foundation paper (B751-01).
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13			Idea that they (different colours) suggest different heat losses / temperatures [1] BUT white / yellow / red / light(er) show most heat loss / highest temperature AW scores [2] Or black / dark blue / purple / dark(er) show least heat loss / lowest temperature [2]	2	Allow (different colours) show where (more) insulation is needed [1] Allow (different colours) show which parts are (well) insulated [1] Allow most heat lost through windows and / roof or less heat lost through walls [1] allow white / yellow / red / light(er) shows where most insulation is needed [2] allow black / dark blue / purple / dark(er) shows where less insulation is needed [2] Examiner's Comments Many knew that the colour of the thermogram was important but failed to explain the correct link clearly enough. Many wrote about where insulation was required and some went on to relate it correctly to the colours and the heat loss e.g. Red and yellow show where most heat is lost so these need more insulation [2]. One common misunderstanding was that blue showed cold areas so these must be losing most heat. Others referred to heat loss but failed to relate it to the colours at all.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a		1800 (J) [1]	1	Examiner's Comments This question about energy use in the home was well answered. Many were able to sensibly interpret the Sankey diagrams and use the concept of efficiency. This enabled them to use processed information in their answers. Most used the Sankey diagrams correctly to give the right answer of 1800J.
	b		60% or 0.6 [2] if answer is incomplete or incorrect then: $\frac{600}{1000} \times 100\%$ [1]	2	allow 60 with incorrect or no unit [1] eg 60 J/s or 60 scores [1] allow 0.6% [1] Examiner's Comments Many gave the correct efficiency calculation but it was common to see answers that failed to write '%' so limiting them to [1] mark.
	c		lowest (useful) energy output / input [1] (usefully) uses a greater proportion of energy / wastes a lower proportion of energy / AW [1]	3	Eg. Uses least amount of energy [1] allow longer time idea explained e.g. Energy = Power x time, and less power but longer time for slow cooker [1] only uses 160J/s (output) 200J/s (input) or only wastes 40J [1] ignore higher / most efficiency allow wastes less energy (than others) [1]

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			BUT 80% or 0.8 efficient / [2]		eg only wastes 20% or 0.2 [2] allow 80 (linked to efficiency) with incorrect or no unit [1] eg. 80 J/s or 80 scores [1] allow 0.8% [1] evidence of the correct efficiency calculation [1] eg 160/200 [1] Examiner's Comments Most calculated the efficiency of the slow cooker as 80% and went on to say it had the lowest energy input for 3 marks. Those that did use calculations could still get [2] marks from the alternatives given in the mark scheme –e.g. It's the most efficient [1] and only wastes 40 [1].
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	(£) 562 [1]	1	
		ii	no (no mark) any one from (£) 5320 is more than (£) 4100 / AW [1] It will cost £5320 (to fit all insulation) [1]	1	allow (£) 1220 shortfall [1]
		iii	payback time (of double glazing) is 25 (years) [2] but if incorrect or no calculation then long(est) payback time scores [1]	2	allow 25 on / at side of table clearly linked to double glazing [2] allow CWI saves £50 per year more than DG [2] allow takes a long time to payback / takes a long time to get your money back / AW [1] allow other correct payback calculations to help prove point: eg. CWI 4 years or DP 120/72 (1.67) or LI 3 years [1] allow does not save as much money per year as cavity wall insulation [1] ignore comparisons of the 'cost to fit' Examiner's Comments Most candidates were able to calculate the saving for the insulation in part (i) and successfully perform the calculation for fitting insulation in part (ii). In part (iii) candidates were asked to perform a calculation; many candidates just quoted data from the table and so were unable to score the full marks.
	b		Level 3: (5 – 6 marks) Reference to red and yellow show most heat escaping AND more heat escapes on a cold day. Quality of written communication does not impede communication of the science at this level.	6	This question is targeted up grade C Indicative scientific points may include: Level 3: yellow / red / white shows higher temperatures than other colours AND cold day means more heat is lost (because of bigger temperature difference) allow reverse argument e.g. blue / black shows lower temperatures than others

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 2: (3 – 4 marks) Simple reference to red and yellow on thermogram show hottest areas OR more heat escapes on a cold day. Quality of written communication partly impedes communication of the science at this level. Level 1: (1 – 2 marks) Simple reference to colours on thermogram show hottest areas. Quality of written communication impedes communication of the science at this level. Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.		AND cold day means more heat is lost (because of bigger temperature difference / heating is on) OR less heat loss on warm day (because of smaller temperature difference) Level 2: - yellow / red / white / lighter colours show higher temperatures than others OR cold day means more heat escapes / have heating on inside the house on a cold day. allow reverse argument e.g. blue / black shows lower temperatures than others OR cold day means more heat escapes / have heating on inside the house on a cold day. Level 1: - some colours show higher temperatures than others Use the L1, L2, L3 annotations; do not use ticks. Examiner's Comments This was a 6 mark question about a thermogram. Most candidates scored some marks by linking the yellow and red to areas that were hot and lost most heat, but few were able to explain why a cold day gave better results. Examiners were looking for the ideal that there was a larger temperature difference between the inside and the outside of the house on a cold day and so a greater amount of heat lost.
			Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16			Correct comparison: cost higher than expected / less than 18% saving / saving is less [1] correct relevant calculation [1] some years are warmer / colder than others [1] the average may not be representative / average calculated over atypical years AW [1] differences in behaviour [1] cost of energy higher in later years [1]	3	allow 2012 and 2013 are higher / 2014 is lower [1] allow average is £920 allow any other correct use of data e.g. 2014 is £98 lower / £32 per year saving / £96 saved over 3 years [1] eg. only 15% lower [2] not merely 'different weather' [0] allow examples e.g. 2009-11 may have been warmer than usual [1] allow examples e.g. Simon may have had windows opened more (often) / more people at home / more time at home / more heating used / more TV watched / settings on heating changed / alterations to house / different or extra appliances used / other or different insulation or energy collecting methods fitted [1] <u>Examiner's Comments</u> The first question on section A module P1 was about heating in the home. The double-glazing advert worked well in that it got candidates into the paper and answering freely with a range of marks being awarded. Most could make a judgement about the energy costs and gained a mark here. Some went on and processed the data further to gain a second mark. Most however attempted an explanation but unfortunately many of these explanations were preoccupied with double glazing and payback cost as a reason for 2012/13 being higher. Some wrote about different weather but were not specific enough to get the mark. Better answer referred to colder winters or windows left open so the heating would have to be used more. About a third of candidates gained two or more marks here.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	3	
17			19800 (MJ) (3) But if answer is incorrect 330 (MW) (2) 66% of 500 or $.66 \times 500$ (1)	3	if no other marks scored allow evidence of power x time (1) allow 500 – 170 OR 330 (2) allow 34% of 500 or $0.34 \times 500 = 170$ (1) Examiner's Comments This question was a developed calculation. The majority of candidates successfully completed the first part of the calculation and calculated the energy loss each second as 330MJ but could not complete the calculation to find the energy lost each minute. Candidates were credited at each stage of the calculation. This question was about generating electricity.
			Total	3	
18			500 000 (MJ) (1)	1	Examiner's Comments Most could calculate the energy input from the coal. Any errors were usually too many or too few zeros in the answer. Also common were: - Those candidates who worked out 34% of the output energy and obtained an answer 57800 J. - Those candidates who divided the output energy by 34 (instead of 34% = 0.34) and obtained an answer of 5000 J.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a		most heat lost from hot / poorly insulated areas indicated by colours white / yellow / red (1) least heat lost from cool / well insulated areas indicated by colours black / dark blue / purple (1)	2	must correctly link heat loss area to correct colour must correctly link heat loss area to correct colour look also for a combination of ideas: eg red areas are hot and lose most heat, purple areas are cold (2) if no mark awarded idea of white is hotter and dark is colder scores (1) Examiner's Comments Virtually all candidates were familiar with thermograms. The question was well attempted although many wrote at length that, 'a thermogram uses colours to show where heat energy is lost' and then omitted to give any colours or to relate them to areas of most or least heat loss. Also there were references to bright or dark, which did not really specify the colour.
	b		all 4 payback times correct in table or elsewhere in answer 48 / 6 / 3 / 2 (1) then idea that they (C and D) have a short / low payback times (1) they (C and D) • save more (annually than A and B) / AW • are cheaper to fit (than A and B) / AW • reduce energy losses by 50% / AW (1) maximum of (1) for each marking point	3	eg D – greatest annual saving (1) eg C is cheapest to fit (1) Examiner's Comments This data handling question on payback time was well answered by most. The calculations were usually correct along with the explanations.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	70% (3) but if answer is incorrect $(7000 \div 10000) \times 100$ (2) but if this is incorrect useful energy = 7000(J) (1)	3	ignore 0.7 on answer line unless % clearly crossed out and no other unit added 0.7 on its own scores max (2) alternatively allow $(3000 \div 10000) \times 100$ (1) Examiner's Comments Most candidates obtained 3 marks for calculating the efficiency correctly and giving 70%. Occasionally 7000/3000 was used, but candidates who wrote this usually got the useful energy mark. Also 30% was obtained on a few occasions.
		ii	idea that wasted energy is given to surroundings / atmosphere / energy is conserved / AW (1) wasted energy and useful energy add up to input energy (so not totally lost / energy just transferred) / AW (1)	1	allow idea that 3000J / wasted energy is converted to different forms of energy (1) Eg. 3000J lost as heat (1) ignore lost as sound allow the idea of energy conservation (1) eg. 7000J + 3000J output = 10000J input eg. combined width / size of output arrows = input (1) Examiner's Comments This proved a challenge for some in that they had difficulties in communicating their idea. Some communicated the idea of conservation clearly or used numbers to illustrate it. Eg. 10 000 input = 3 000 + 7 000 output [1]. Others were able to explain that the energy was not lost but wasted as heat [1].
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20			0.34 or 34% (2) but if answer incorrect 170 000 (MJ) / 500 000 (MJ) ($\times 100$) (1)	2	0.34% (1) 34 (1) Examiner's Comments Candidates, in general correctly calculated the efficiency of the power station.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
21	a		colour(s) (1) thermogram (1)	2	ignore shades of grey / black and white allow thermograph allow thermophotograph ignore thermal image / photograph ignore infrared image / photograph Examiner's Comments Most candidates knew that thermal imaging cameras produce photographs that show different colours and most of those candidates knew that the picture was called a thermograph or themogram. Thermal image was not allowed as this was given in the question.
	b		max two from: double glazing (in the windows) cavity wall insulation / foam in wall cavity loft insulation insulation above ceiling (2) max two from: measure(s) suggested have trapped air in them (1) (trapped) air is a good insulator (1)	3	allow carpets on the floor allow curtains at the window ignore wall insulation on its own ignore roof insulation on its own ignore reduces energy loss allow higher level answers in terms of correctly identified reduction of conduction / convection / radiation Examiner's Comments Candidates were asked to describe energy saving methods and explain how air is important. Examiners did not accept simplistic answers such as 'insulate the roof' or 'insulate the walls'. A more detailed description was needed, for example, insulate the roof with fibreglass or fill the cavity in the walls with foam. A maximum of 2 marks was awarded for method, and a maximum of 2 marks was awarded for describing how air was important. The question had a maximum of 3.
			Total	5	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
22	Level 3 (5–6 marks) Candidates must conclude correctly and quantitatively the efficiencies or fractional energy loss or output of both heaters. This should be justified with reasons for the different efficiencies. When only one reason is in the answer award 5 marks. Quality of written communication does not impede communication of science at this level. Level 2 (3–4 marks) Candidates must conclude that heater A is more efficient and offer a reasonable qualitative or quantitative explanation as to why. Correct efficiency or fractional calculations will be awarded 4 marks. When only one heater explained award 3 marks. Quality of written communication partly impedes communication of science at this level. Level 1 (1–2 marks) Answers should have a simple explanation that heater A gives more heat to room and B gives less to the room or a reason for this. When only one heater is mentioned or the reason is unclear award 1 mark. Quality of written communication impedes communication of science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to E Relevant points include: heater A • efficiency is 0.8 or 80% • gives more heat to the room / AW • (only) 1/5 of energy / heat goes up chimney • has a lower energy input • less energy given to wall / less wasted • is all in room • has a larger surface area giving out heat • black /dark colour emits more heat heater B • efficiency is 0.5 or 50% • gives less heat to the room / AW • ½ of heat / energy goes up chimney • has greater energy input • more energy given to wall / up chimney / wasted • is in / behind the wall • has a smaller surface area giving out heat • white / light colour emits less heat A or B: heaters have different flue / chimney systems Use the L1, L2, L3 annotations in scoris. Do not use ticks. Examiner's Comments The best answers quickly got to the point; the correct efficiency calculations were followed by reasons for the higher efficiency of heater A. Good answers that did not score 6 marks failed to justify the higher efficiency, whilst weaker answers merely gave some information about A and / or B without references to efficiency. Candidates should be aware that merely regurgitating information from the question will gain little or no credit. Few responses

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					contained any mention of emissions from darker or lighter surfaces.
			Total	6	
23		i	70% (3) but if answer is incorrect $(7000 \div 10000) \times 100$ (2) but if this is incorrect useful energy = 7000(J) or $(3000 \div 10000) \times 100$ (1)	3	ignore 0.7 on answer line unless % clearly crossed out and no other unit added 0.7 on its own scores a maximum (2) Examiner's Comments Most candidates correctly calculated the efficiency of Allan's boiler and identified it as being in band F which was next to the bottom band.
		ii	yes (no mark) in the second worst / second bottom (efficiency) band or in the worst / lowest two (efficiency) bands / in band F (1)	1	allow ecf from c (i) if correctly linked allow one of the worst / there are five bands above it
			Total	4	
24	a		spray foam (1) thinnest / lowest thickness / AW (1)	2	allow less needed or only 74mm needed ignore takes up less space Examiner's Comments The common error was to choose 'Sheep's wool', presumably because those candidates thought that the largest recommended thickness of insulating material would be best.
	b		(foil) reflects heat or IR or energy (back into house) (1)	1	ignore attracts heat ignore bounces ignore particles not merely reflects Examiner's Comments Usually correct but reflecting light, absorbing, attracting or blocking IR or heat were poor answers given by some candidates. Heat or heat particles bouncing off the foil appeared in some answers.
			Total	3	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
25	Level 3: (5 – 6 marks) Temperature rises calculated correctly AND correct judgement made AND a detailed explanation of one or more mechanisms Quality of written communication does not impede communication of the science at this level. Level 2: (3 – 4 marks) Temperature rises calculated correctly AND correct judgement made and a part explanation. Quality of written communication partly impedes communication of the science at this level. Level 1: (1 – 2 marks) Temperature rises calculated correctly OR correct judgement made. Quality of written communication impedes communication of the science at this level. Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade E Indicative scientific points may include: Explanation and mechanisms: • (colour) black absorbs heat / energy (better) • (surface) shiny reflects heat / energy (away) or • air is a good insulator / AW • (material) expanded polystyrene is a better insulator • (material) expanded polystyrene traps air • Polystyrene without air bubbles is a better conductor Judgement made (any one judgement): • C chosen as the best cup to keep the drinks cooler • C heats up the least • A B and D are worse at keeping the drinks cool • A B and D heat up more • Temperature rises calculated: • A – 80°C • B – 140°C • C – 20°C • D – 50°C allow heat for IR ignore light Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					This was a six mark extended prose level of response question and was targeted at the lower grades G, F and E. Most candidates calculated the temperature rises correctly to satisfy the level 1 criterion. Most answers also went on to also select C as the best choice for keeping the drink cool [4]. Level 3 answers needed some scientific explanation about shiny surfaces reflecting the IR radiation or energy away. Others answered in terms of the bubbles trapping air leading to good insulation.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
26	a		80 (%) or 0.8 [2] but if answer is incorrect $100 \times 800 / 1000$ or $800 / 1000$ [1]	2	0.8% [0] Take the answer on the answer line first. If this answer is absent or incomplete then mark the answer in the table. ignore any units Examiner's Comments Mostly correct efficiency calculations of 80% or 0.8 [2].
	b		any one from both 50% efficient [1] both 50% efficient or 0.5 [1] both use (only) 50% of energy (input) [1]	1	Ignore equally efficient allow half energy lost / they are both half [1] idea that both have same ratio of input: absorbed energy / AW [1] allow $600/1200 = 700/1400$ [1] Examiner's Comments This was a different way of approaching data and the concept of efficiency. It was answered well with most responses showing 50% efficiency in the table. Other answers such as 'the energy absorbed is half the input' also gained the mark.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		appropriate equipment any one from suitable equipment or use of equipment thermometer [1] stopwatch [1] measure time to cook the food [1] measure a temperature [1] fair test any two from same amount of food / same mass of food / same volume of food / same meal [1] same container [1] same time / same time intervals [1] same starting temperature [1] method / procedure maximum of two from measure temperature rise [1] (by) measuring the start and finishing temperatures [1] measure time to heat the food up to same temperature) [1]	3	maximum 3 marks award same marking points if shown on a diagram ignore 'same food' or 'same type of food' Examiner's Comments This three mark question invited candidates to describe an experiment to find the fastest cooking oven. Some had ideas on measuring times / temperatures or using stopwatches / thermometers [1]. Some also had an idea of controlling variables, eg same amount of same food [1] or heat each for the same time [1]. Rather fewer could describe the end point convincingly. Eg. time how long it takes to heat the foods by 50°C. Most were more vague and used phrases like 'time how long it cooks for', etc.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
27			Factor (no mark) any two from (idea that) efficiency decreases with increasing current [1] best efficiency at 4 amps or best efficiency at 4 amps is 94% [1] best efficiency at 6 amps is 87% [1] (idea that) motor needs to have the best efficiency in range between 4 amps and 6 amps [1]	2	ignore choice of motor if no marks awarded allow the idea that Factor has the highest average efficiency [1] Examiner's Comments This "how science works" question involved choosing the most efficient motor using data across a range of currents. Although most candidates could correctly identify the best choice of motor most struggled to explain two acceptable reasons for this choice using the data provided.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
28			one payback time calculated (1) and any one from: draught proofing because it has the shortest payback time (2) loft insulation because it saves the most each year/AW (2) cavity wall insulation because it has the largest yearly saving/AW (2)	3	double glazing 100 years loft insulation 2 years cavity wall insulation 3 years draught proofing 0.5 years/6 months no marks for insulation on its own, must be linked to correct reason for (2) allow 1 mark for draught proofing is cheapest to install if no marks scored on the second part, allow a second mark if two correct payback times calculated
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29			Level 3: 5–6 marks Two detailed quantitative comments / comparisons and a reasoned decision made. Quality of written communication does not impede communication of science at this level. Level 2: 3–4 marks Two quantitative comments / comparisons or two simple comments / comparisons and reasoned decision. Quality of written communication partly impedes communication of science at this level. Level 1: 1–2 marks Two simple comments / comparisons (qualitative) Quality of written communication impedes the communication of science at this level Level 0: 0 marks Insufficient or irrelevant science. Not worthy of credit.	6	This question is targeted up to C Indicative scientific points may include (but are not limited to) the following: Allow correct statements that refer to halogen bulbs <u>Level 3</u> Leo should buy LED bulbs for 25000 hours you need 1 LED bulb for £6 and 10 halogen bulbs for £15 the saving is £9 for LED bulbs the energy cost for the LED bulb will only be a sixth of that for halogen bulbs <u>Level 2</u> LED bulbs cost four times halogen bulbs to buy LED bulbs last ten times longer than halogen bulbs halogen bulbs use six times the energy compared to LED bulbs <u>Level 1</u> halogen bulbs are cheaper to buy LED bulbs last longer halogen bulbs use more energy than LED bulbs
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
30			1,050,000 J (3) If incorrect or incomplete then: 450000 J (2) or $1,500,000 \times 0.3$ (1)	3	
			Total	3	
31			any two from less or least energy transferred to the surroundings (1) for the same amount transferred to moving the robot (1) most efficient (1)	2	
			Total	2	
32			0.3 or 30% (2) If incorrect or incomplete then: $30 / 100$ or $30 \times 100/100$ or 0.3% or 30 (1)	2	
			Total	2	
33			D ✓	1 (AO2.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
34			B ✓	1 (AO2.2)	Examiner's Comments  Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below. Exemplar 1 11 A pump lifts 500 kg of water to a water tank at the top of a building. The water gains 240 000 J of gravitational potential energy. The gravitational field strength is 10 N/kg. Use the equation: Potential energy = Mass × Height × Gravitational field strength Calculate the height of the water tank. $\frac{240000}{500 \times 10}$ A 4.8 m B 48 m C 240 m D 480 m Your answer ☐ b [1]
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
35		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks $(P =) I^2 \times R$ ✓ $11 \times 11 \times 23$ or $11^2 \times 23$ or 121×23 ✓ $= 2783$ ✓ Conversion to kW = 2.8 ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO2.1)	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓ ALLOW equation in any form ALLOW ECF candidates answer to 3rd marking point converted to kW Examiner's Comments This question required candidates to recall the equation: <i>power = current² x resistance</i> before converting their answers into kW. Out of the candidates who gained credit, most were credited with all four marks. A few candidates were only credited with one mark for converting the power output in W into kW. A significant number of candidates used an incorrect equation for power, most commonly using <i>current</i> rather than <i>current²</i>  AfL When a physics question requires candidates to apply their mathematical skills they should always write down how they are answering the question. Using brief notes is and writing down intermediate calculations helps the examiner to see what the candidate is doing. A single finger error will result in many candidates receiving no credit because they only write down their final answer. Marks may be available for each stage of the process, using the correct equation, rearranging the equation, substituting in correct values. Choosing to access

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					these compensatory marks by showing workings is good examination technique.
		ii	Wind speed varies / AW ✓	1 (AO2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO2.1)	ALLOW (it) may not generate enough power / energy / AW <u>Examiner's Comments</u> Most candidates gained full credit for Q16(d)(ii) and (d)(iii). Those who did not gain credit often provided non-specific generalised reasons about the weather or the wind turbine 'breaking'.
			Total	6	
36			C ✓	1 (AO 2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 60 000 (J) award 2 marks 48 000 + 12 000 ✓ = 60 000 (J) ✓	2 (AO 2.2) (AO 2.2)	Check table <u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		ii	C ✓	1 (AO 3.2b)	<u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		iii	B ✓	1 (AO 3.2b)	<u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	Heat / sound / KE of particles passed to other particles / AW ✓	1 (AO 1.1)	ALLOW (energy) transferred to surroundings / by friction Examiner's Comments A large number of candidates correctly stated that the motor would produce heat and/or sound or indicated that the energy was 'wasted' through friction. Some candidates wrote out all the energy transfers in an electric motor (e.g. "heat, sound and kinetic energy") which could not gain credit as it did not describe how energy is 'wasted'. Credit was given when it was clear that the 'waste' resulted from the transfer of the kinetic energy store of particles passed on to other particles or to the surroundings but not a vague transfer of 'kinetic energy to the atmosphere'.
		v	Lubrication / oil ✓	1 (AO 2.1)	ALLOW reduce friction Examiner's Comments Candidates found this question extremely challenging. There were very few suggestions of specific improvements to the electric motor such as lubricating it or applying oil to the moving parts. Many candidates suggested general energy efficiency tips such as switching it off when it not in use, running the motor at a slower speed or putting insulation around the motor.

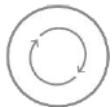
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 89 (%) award 3 marks $48\,000 \div 54\,000 (\times 100) \checkmark$ $= 88.88888\dots\text{etc} \checkmark$ $= 89(\%)$ (2 sig figs) $\checkmark$	3 (AO 2.1) (AO 2.1) (AO 1.2)	ALLOW two marks for 0.89 or 88(%) ALLOW one mark for 0.88 Examiner's Comments Two thirds of candidates were credited with some marks for this question. Candidates needed to use the equation provided and give their final answer as a percentage. Many candidates did not show any working so could only be credited with any marks if their final answer was correctly given as a percentage. There was a compensatory mark for showing 48000 divided by 54000 in a candidate's workings which almost every candidate could have accessed.  OCR support The answer to two significant figures is 89%. Many candidates gave their final answer to two significant figures as 0.8/ 80% or 0.9/90% or 0.88 /88%. The Mathematical Skills Handbook provides support on the use of significant figures and other required mathematical skills. http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	9	

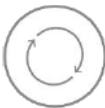
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
38		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks $(P =) I^2 \times R$ ✓ $11 \times 11 \times 23$ or 112×23 or 121×23 ✓ = 2783 ✓ Conversion to kW = 2.8 (kW) ✓	4 (AO 1.2) (AO 2.1) (AO 2.1) (AO 2.1)	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓ ALLOW equation in any form ALLOW ecf candidates answer to 3rd marking point converted to kW Examiner's Comments Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11×23 or $23 \div 11$, rather than $112 \times 23 = 2.78\text{kW}$.
		ii	Wind speed varies / AW ✓	1 (AO 2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW Examiner's Comments Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	
39			D ✓	1 (AO 2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
40			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.28 (W) award 3 marks Recall (Power =) potential difference x current ✓ 12×3.19 ✓ (P =) 38.28 (W) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW correct equation in any form ALLOW 38.3 (W) or 38 (W) <u>Examiner's Comments</u> Candidates had to recall the equation: power = potential difference x current and substitute the values provided in the question. Most candidates achieved full marks although some of the less able candidates could not recall the equation and therefore gained no credit.  AfL Candidates would benefit from writing down the equation and their calculations rather than just their final answer so that compensatory marks may possibly be awarded.
			Total	3	
41			B ✓	1 (AO2.1)	<u>Examiner's Comments</u> This question was well answered. Higher ability candidates used the space around the question for their working. Exemplar 1 5 A boiler has an input energy of 720 kJ from the gas it burns. It transfers 540 kJ of useful energy to the home. What is the efficiency of the boiler? Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$ A 0.12 B 0.75 C 0.90 D 1.33 Your answer B This exemplar shows the candidate identifying the correct numbers for the given equation.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
42	a	i	40 (°C) ✓	1 (AO2.2)	<u>Examiner's Comments</u> The majority of the candidates calculated the difference correctly. Higher ability candidates often wrote $100 - 60 = 40$
		ii	Any one from: Difference is much too high / difference should be lower than the previous result AW ✓ End temperature is too low ✓	1 (AO3.2a)	ALLOW does not follow the trend/pattern IGNORE not stirring/thermometer touching the bottom / start temperature / boiling temperature <u>Examiner's Comments</u> This question required candidates to identify that the last difference did not follow the pattern. The start temperature in this case was irrelevant and was not credited. Many candidates correctly identified that the end temperature was too low or that the temperature difference was too large. Candidates should be encouraged to include a comparison in this type of question.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		All points plotted correctly ✓ Appropriate straight line of best fit ✓	2 (AO 2×2.2)	ALLOW tolerance of $\pm$ half a square DO NOT ALLOW straight line from top to bottom ALLOW ECF for mis-plotted data points <u>Examiner's Comments</u> Many data points and lines were too thick. The second and fourth data points were often incorrectly plotted. It was expected that a straight line of best fit would be drawn. A large number of candidates drew lines dot-to-dot. AfL Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. Straight lines should be drawn with a ruler. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.
	c		(As thickness of the insulation increases) temperature difference falls / ORA ✓	1 (AO3.1a)	<u>Examiner's Comments</u> The majority of candidates correctly stated that the temperature difference falls as the thickness of the insulation increases. Higher ability candidates included in their answer "as the thickness of the insulation increases".

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		As thickness increases rate decreases / AW / ORA ✓	1 (AO3.2b)	ALLOW as thickness increases tea cools slower / takes longer to cool ORA <u>Examiner's Comments</u> Many candidates omitted to indicate a direction of change for the thickness of the insulation. Other candidates did not understand the meaning of the term 'rate'.  AfL Candidates should be encouraged to practise explaining equations in terms of the effect of increasing a quantity on another quantity.
	e		Any two from: Keep starting temperatures the same ✓ Keep room temperature the same ✓ Stir tea before taking measurements ✓ Use a lid / add (same) insulation underneath the cup / cover whole cup in (same) thickness insulation ✓ Repeat <u>and</u> average	2 (AO2×3 .3b)	<u>Examiner's Comments</u> In this type of question, candidates need to give detailed ways of improving the experiment. Many candidates stated add insulation without being specific that the insulation should be either under the tea or as a lid. A number of candidates stated correctly that the start temperature should be the same and the room temperature should also be the same.
			Total	8	

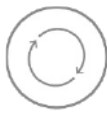
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
43	a	i	Any one from: Ratio of 1:1 at a height of 40 cm ✓ ratio (seems to) increase by 0.1 when height decreases by 20 cm (until ratio is 1:1) / AW ✓	1 (AO3.2a)	ALLOW when drop height was 40 cm, bounce height was the same / bounce ratio coming closer to 1:1 each time / bounce height cannot be higher than drop height <u>Examiner's Comments</u> Many candidates answered this question correctly by referring to the previous bounce height being the same. This question again required candidates to interpret data from a table.
		ii	Some of the energy from the KE store is transferred to other energy stores as ball hits the ground AW ✓	1 (AO2.1)	ALLOW ball will lose energy (when it hits the ground) <u>Examiner's Comments</u> There was a clue in the question regarding energy. It was anticipated that candidates would understand that there is likely to be energy losses both as the ball travels through the air and as it bounces. It was hoped that there would be reference to energy being transferred from the kinetic energy store to other energy stores as the ball bounces.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		Any two from: Lower head to read bounce height / take bounce height readings at eye level / AW ✓ Take multiple readings and <u>average</u> them ✓ Take readings at other intervals (eg. 90, 70, 50) ✓	2 (AO2×3 .3b)	ALLOW second person to read bounce height / idea of video camera and play back ALLOW drop from greater heights <u>Examiner's Comments</u> This was another question which required candidates to consider experimental procedures. Many candidates suggested taking other readings. Some candidates tried to suggest methods of improving the measurement of the bounce height but often the explanations were vague and lacked the necessary detail.  AfL Candidates should be encouraged to consider improvements to experiments that are carried out as part of their practical course.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
44			As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓	2 (AO 3.1a) (AO 3.2b)	ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = $2 \times 10 = 20$ (m) for 2 marks <u>Examiner's Comments</u> Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed. The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.  AfL Understand how to test from a graph whether two quantities are directly proportional. 1. Take a quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2. See whether there is a straight line through the origin.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
45	a		Change the thickness of the cardboard (and repeat) ✓ Any 2 from: (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer / time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	3 (AO3 × 3.3a)	ALLOW use different boxes with different thicknesses / line the box with an insulator ALLOW same beaker / both beakers (don't) have a lid / same room temperature ALLOW a specified amount of water in the beaker / a specified starting temperature
	b	i	5 or 4 points correctly plotted to within ½ small square ✓✓	2 (AO2 × 2.2)	3 or 2 correctly plotted points gains 1 mark IGNORE 'blobs' more than ½ square diameter
		ii	Smooth curved line of best fit through most points ✓	1 (AO1.2)	DO NOT ALLOW a straight line of best fit
		iii	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2 (AO2 × 3.1a)	IGNORE non-linear relationship / positive/negative correlation ALLOW inverse proportion for this mark only ALLOW gradient decreases / temperature decreases more quickly at the start (than at the end) ALLOW use of data from the graph to show decreasing rate
		iv	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	2 (AO3.2b)	IGNORE shape of the line but no mark for a horizontal line ALLOW 90 +/- 2 °C
		v	Any one from: Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	1 (AO3.3b)	ALLOW any sensible suggestion IGNORE a longer time / use more thicknesses ALLOW use equipment with higher resolution / data logger IGNORE better equipment unless qualified

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1 (AO3.2a)	ALLOW metal is a (better thermal) conductor / ORA
			Total	11	
46			Change the thickness of the cardboard (and repeat) ✓ Any 2 from: (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer / time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	3 (AO3 × 3.3a)	ALLOW use different boxes with different thicknesses / line the box with an insulator ALLOW same beaker / both beakers (don't) have a lid / same room temperature ALLOW a specified amount of water in the beaker / a specified starting temperature
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
47		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 72 (%) award 5 marks Select from data sheet: change in thermal energy = mass × specific heat capacity × change in temperature (no mark) (change in thermal energy =) $1.2 \times 4200 \times 75$ ✓ (change in thermal energy =) 378 000 (J) ✓ (Recall: efficiency =) useful output energy transfer / input energy transfer OR (Efficiency =) $378\,000 / 525\,000$ ✓ (Efficiency =) 0.72 ✓ (Efficiency =) 72 (%) ✓	5 (AO1.2) (AO2.1) (AO1.2) (AO2.1) (AO1.2)	ALLOW ecf for incorrect thermal energy calculated ALLOW 4 marks for answer of 0.72 (%)
		ii	some energy is transferred to the (thermal energy store of the) kettle/surroundings/air ✓	1 (AO2.1)	IGNORE sound
			Total	6	
48			Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1 (AO3.2a)	ALLOW metal is a (better thermal) conductor / ORA
			Total	1	
49			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.9 (A) award 2 marks (Rearrangement: $I_p = I_s \times V_s / V_p$) ✓ OR ($I_p =$) $12 \times 9.0 / 120$ ✓ ($I_p =$) 0.9 (A) ✓	2 (AO1.2) (AO2.1)	
			Total	2	