

PHYSICS



EXAM QUESTION PACK

WS1.1 DEVELOPMENT OF SCIENTIFIC THINKING

SCORE

/226

PERCENTAGE

%

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Gateway Physics A (9-1)

Development in scientific thinking

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 **226**.
- The total number of marks may take into account some 'either/or' question choices.

1

'Cold fusion' is fusion at room temperature.

An Italian inventor claims he has achieved 'cold fusion'.

He has demonstrated his claims but has **not** shared any details or data.

(i) Explain why it is important to share details and data with other scientists.

----- [1]

(ii) Explain why 'cold fusion' is **not** accepted as a method of energy production.

----- [1]

2 Which voltage is the maximum voltage made when **four** 1.5 V cells are connected in **series**?

A 0 V

B 1.5 V

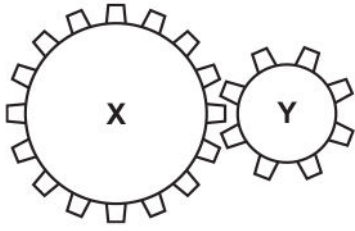
C 3.0 V

D 6.0 V

Your answer

[1]

- 3 Cog X has 16 teeth and cog Y has 8 teeth.



Cog X is turned around **two** times.

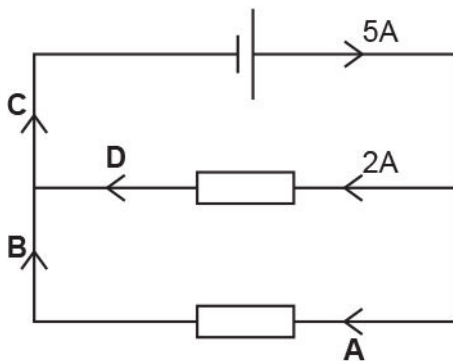
How many times does cog Y turn around?

- A 1
- B 2
- C 4
- D 8

Your answer

[1]

- 4 This is a circuit.



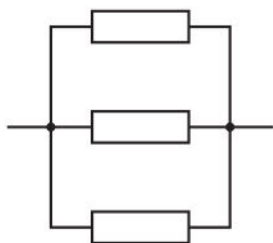
Which letter A, B, C or D shows the part of the circuit that carries a current of 2 A?

Your answer

[1]

5 A student has 3 identical resistors. She arranges them in four different ways.

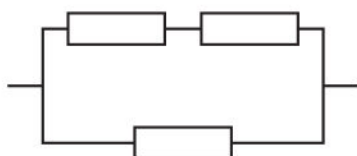
A



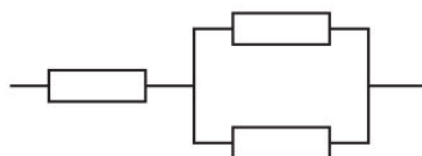
B



C



D



Which arrangement has the **most** resistance?

Your answer

[1]

6 In which situation does the force cause a rotation?

- A Bouncing on a trampoline
- B Hitting a nail with a hammer
- C Pushing a friend on a swing
- D Sitting on a chair

Your answer

[1]

7 Which is a scalar?

- A Acceleration
- B Displacement
- C Force
- D Speed

Your answer

[1]

8 These statements are about pressure and volume of a gas.

Which statement is correct?

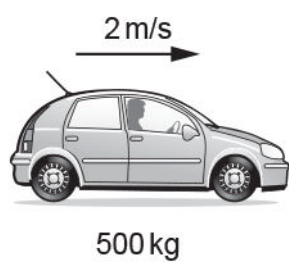
- A Volume doubles, pressure doubles
- B Volume doubles, pressure halves
- C Volume halves, pressure halves
- D Volume halves, pressure stays constant

Your answer

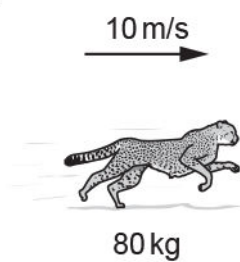
[1]

9 Which of the following has the **most** kinetic energy?

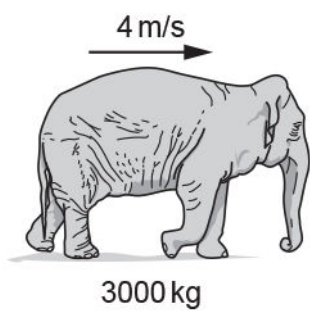
A



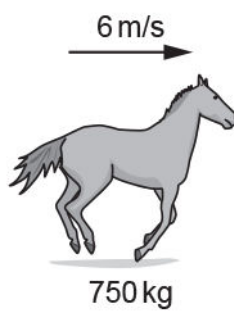
B



C



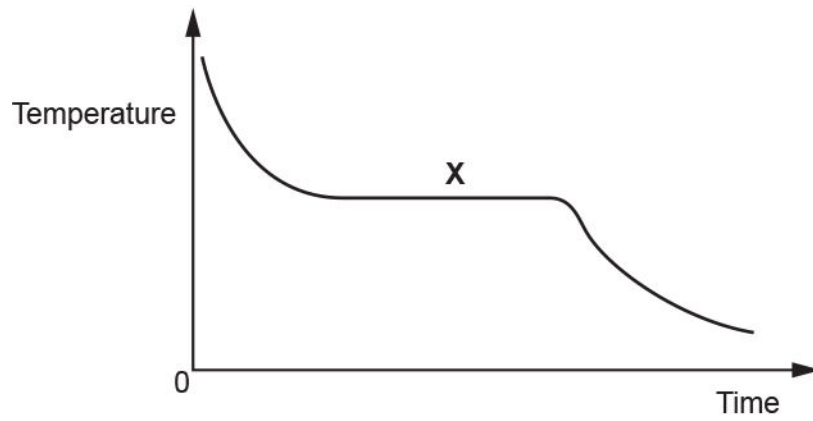
D



Your answer

[1]

10 A student studies how the temperature falls when a liquid cools.



What is happening at point X on the graph?

- A Boiling
- B Freezing
- C Melting
- D Subliming

Your answer

[1]

Look at the table.

(i) Which appliance uses the **most** energy?

(ii) Which appliance uses the **least** energy?

(b) Here are three different components and their use in the home.

Match the component to its correct use.

One has been done for you.



(c) A charge of 44 000 C flows through a light bulb. The potential difference is 230 V.

Calculate the energy transferred.

Use the equation: Charge = Energy ÷ Potential difference

Record your answer to 2 significant figures.

Answer = ... J [4]

12 Atomic models have changed over time.

Old atomic model – Atoms are a positive mass with negative electrons fixed in it.

Current atomic model – Atoms are made from protons, neutrons and electrons.
Protons and neutrons are in a central nucleus surrounded by a cloud of electrons.

(i) Write down **two** differences between these models.

1

2

[2]

(ii) Why did the atomic model change?

[2]

13 * Four students run in different races.

Student	Race distance (m)	Time (s)
A	50	6
B	100	15
C	100	14
D	200	31

Use the information in the table to **describe** and **compare** the motion of the four students.

Use the data in your answer.

[illegible]

14(a) A book rests on a table.

Draw a free body force diagram to show the forces acting on the book.

Use arrows to represent the forces.

[4]

(b) A presenter on a car TV programme says:

“The car maker has reduced the mass of this car and it now has better acceleration.”

(i) Explain why the presenter is correct.

----- [2]

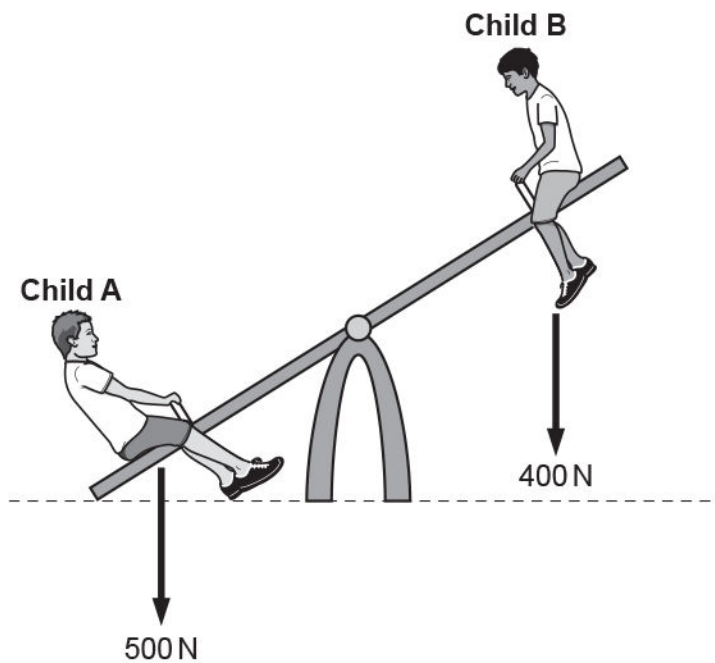
(ii) A car accelerates from 5 m/s to 25 m/s in 4 seconds.

Calculate the acceleration of the car.

Use the equation: Acceleration = Change in speed ÷ Time taken

Answer = ... m/s² [3]

15 Two children play on a seesaw.



Both children sit 2 m from the pivot.

Calculate the clockwise and anti-clockwise moments around the pivot when the seesaw is horizontal.

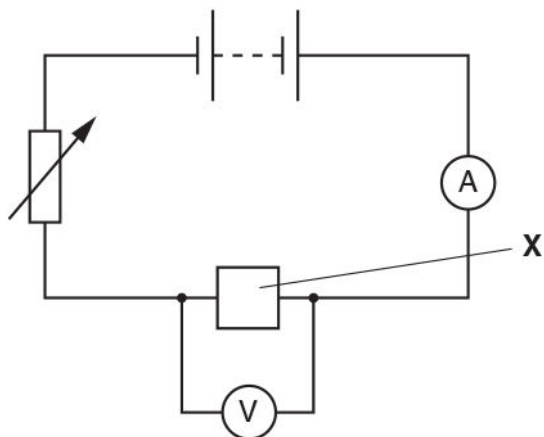
Clockwise moment = ... Nm

Anti-clockwise moment = ... Nm
[3]

Calculate where **Child A** should sit to balance the seesaw.

Answer = ... [3]

16 A student builds a circuit to investigate the resistance of component X.



Component X has a resistance of $16\ \Omega$ when a current of $0.25\ \text{A}$ flows.

(i) Calculate the potential difference across component X.

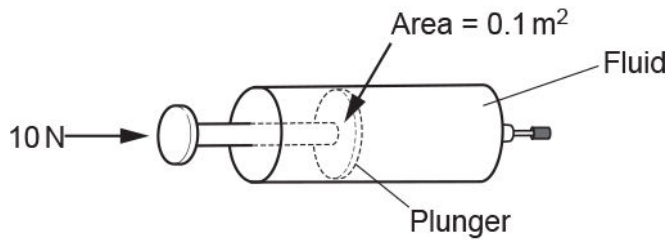
Use the equation: Potential difference = Current $\times$ Resistance

Answer = ... V [2]

(ii) Calculate the power of component X when a current of $0.25\ \text{A}$ flows.

Answer = ... W [3]

- 17 A student tries to compress the fluid in a sealed syringe with a force of 10 N.



The area of the end of the syringe is 0.1 m².

- (i) Calculate the pressure in the fluid.

Answer = ... Pa [3]

- (ii) Write down the direction of the force produced by the fluid on the plunger.

-----[1]

18 The behaviour of a magnetic compass is evidence that the core of the Earth is magnetic. Explain why.

[2]

19 The atomic model has changed over time.

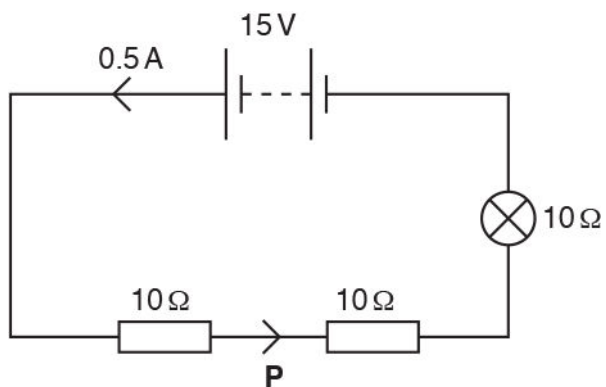
Why did the model need to change over time?

- A Models only have a finite lifetime
- B Computers were invented
- C The older models could not explain new evidence
- D Peer review

Your answer

[1]

20 What is the current at point **P** in the circuit?



A 0.5 A

B 7.5 A

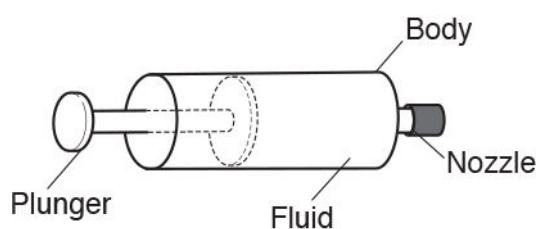
C 15.0 A

D 20.5 A

Your answer

[1]

21 A fluid is compressed by pushing the plunger into the body of a sealed syringe.



Which of these statements is true?

A There is a net force towards the plunger.

B There is no force towards the nozzle.

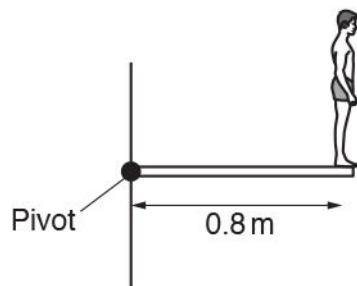
C There is a force parallel to all points on the surface of the fluid.

D There is a force at 90° to all points on the surface of the fluid.

Your answer

[1]

22 A diver stands on a diving board. He weighs 400 N.



What is the moment of the force provided by the diver around the pivot?

- A 320 Nm anti-clockwise
- B 320 Nm clockwise
- C 500 Nm anti-clockwise
- D 500 Nm clockwise

Your answer

[1]

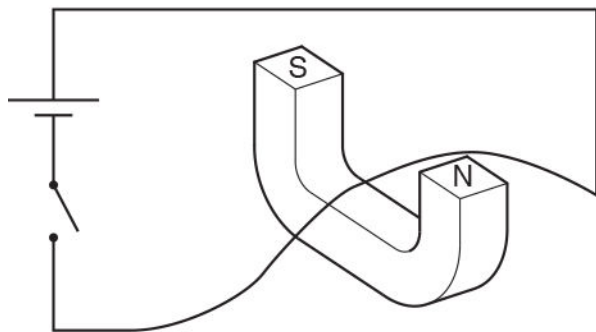
23 Which factor influences whether an object floats or sinks?

- A Size of object
- B Depth of water
- C Distance from the shore
- D Density of object

Your answer

[1]

24 A wire is placed inside a horseshoe magnet.



Which direction will the wire move when the switch is closed?

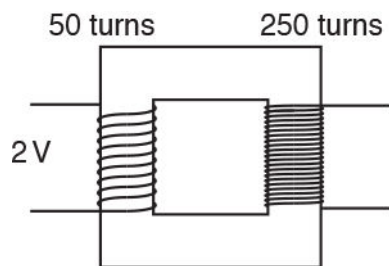
- A** Downwards
- B** Left
- C** Right
- D** Upwards

Your answer

5

[1]

25 What output voltage does the transformer produce?



A 0.2 V

B 0.4 V

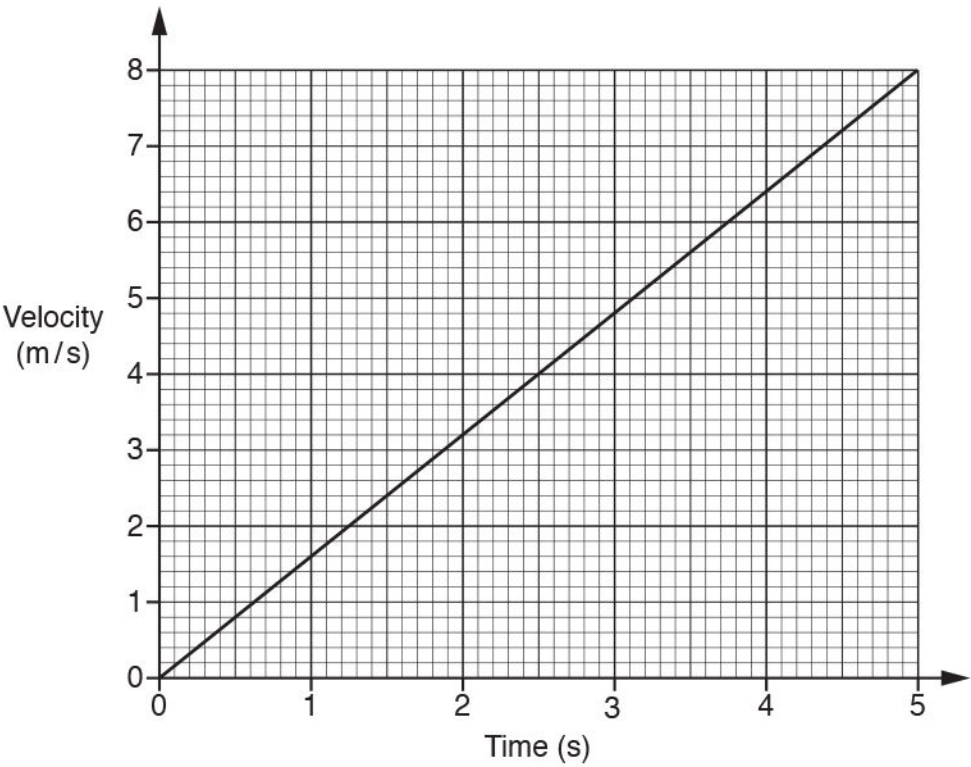
C 5 V

D 10 V

Your answer

[1]

26 Look at the velocity-time graph of an object.



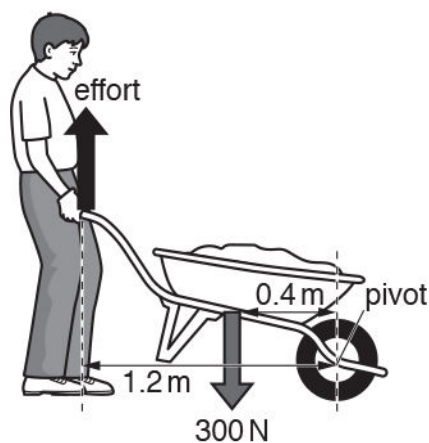
What is the distance travelled by the object in 5s?

- A 0.63 m
- B 1.6 m
- C 20 m
- D 40 m

Your answer

[1]

27 A man lifts a load using a wheelbarrow.



What is the effort needed to lift the load using the wheelbarrow?

- A 100 N
- B 120 N
- C 250 N
- D 144 N

Your answer [1]

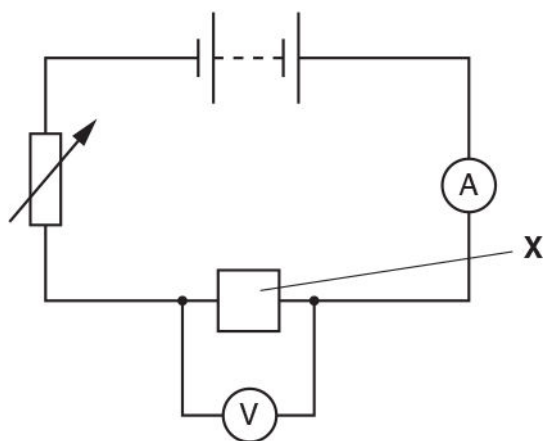
28 A 0.5 m length of wire is placed inside four different magnetic fields.

Magnetic Field	Force on wire (N)	Current in wire (A)
A	2.0	0.1
B	2.0	0.2
C	4.0	0.1
D	4.0	0.4

Which magnetic field has the **greatest** magnetic flux density?

Your answer [1]

29 A student builds a circuit to investigate the resistance of component X.



Component X has a resistance of $16\ \Omega$ when a current of $0.25\ \text{A}$ flows.

(i) Calculate the potential difference across component X.

Use the equation: Potential difference = Current $\times$ Resistance

Answer = ... V [2]

(ii) Calculate the power of component X when a current of $0.25\ \text{A}$ flows.

Answer = ... W [3]

30 The behaviour of a magnetic compass is evidence that the core of the Earth is magnetic. Explain why.

----- [2]

(i) Write down the conditions needed for charge to flow through a conductor.

----- [2]

(ii) Calculate the charge that flows past a point in a circuit with a 5.0 A current for five minutes.

Answer = ... C [4]

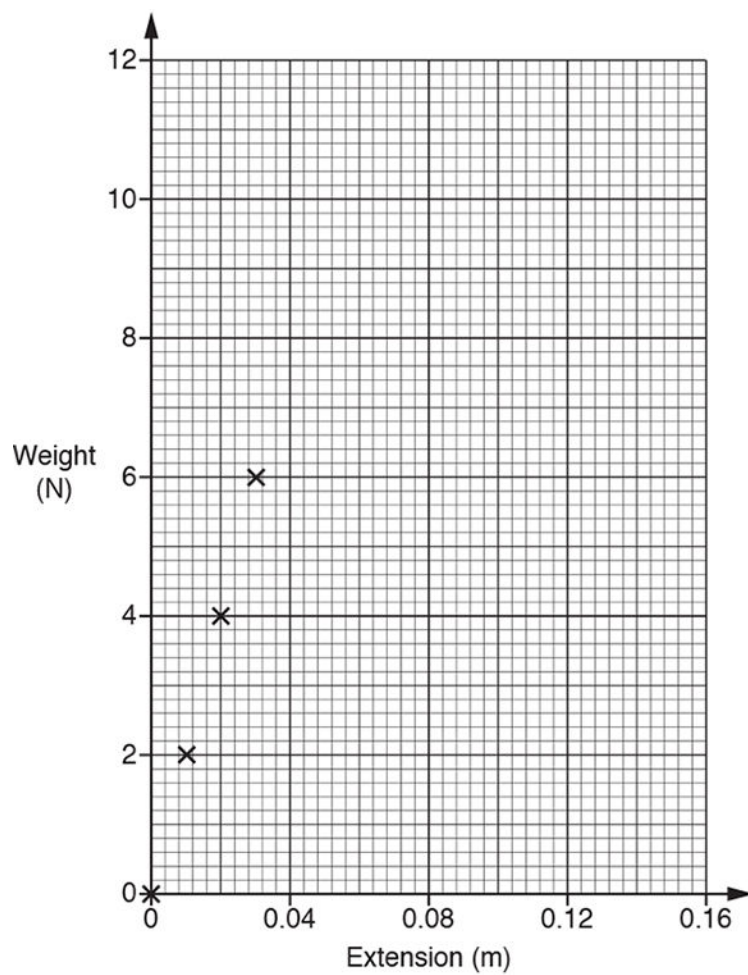
32(a) A student hangs a length of copper wire from the ceiling.

She adds weights to the bottom of the wire and measures the extension of the wire.

Look at a table of some of her results.

Weight (N)	Extension (m)
0	0
2	0.01
4	0.02
6	0.03
8	0.04
10	0.08
12	0.16

(i) Plot the values on the graph. Some have been done for you.



[2]

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

[1]

(iii) Describe and explain the shape of the graph.

[3]

(b) Calculate the spring constant for the 0 – 6 N part of the graph.

Use the equation: Force = Spring constant $\times$ Extension

Answer = ... N/m [3]

(c) Calculate the work done in stretching the wire to 0.04 m.

Answer = ... J [2]

33 A student finds that 250 g of ice takes 95 kJ of energy to change state.

Calculate the specific latent heat.

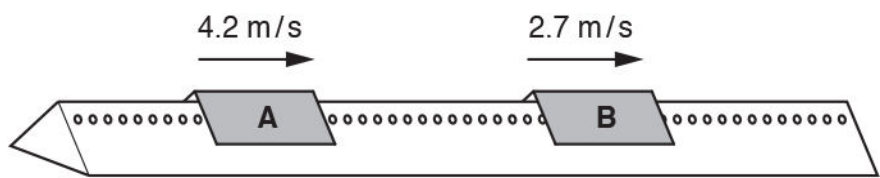
Answer = ... J/kg [3]

34(a) A student investigates collisions of trolleys on a horizontal airtrack.

Write down the **two** quantities involved with motion which are conserved during an elastic collision.

-----[2]

(b) Trolley A has a mass of 2 kg. Trolley B has a mass of 2.5 kg.



(i) Calculate the **momentum** of each trolley.

Trolley A = ... kg m/s
Trolley B = ... kg m/s
[3]

(ii) The two trolleys collide and stick together after the collision. Use your answers to (i) to calculate the **speed** of the combined trolleys after the collision.

Record your answer to 2 significant figures.

Answer = ... m/s [3]

35(a) A student wants to find out the depth of a well.

She thinks that she can calculate this by dropping a stone into the well and timing how long it takes to hear the stone splash at the bottom.

(i) Explain how she could use this measurement to find the depth of the well.

----- [3]

(ii) It takes 2.2 seconds for the stone to drop from rest and splash into the water at the bottom.

What is the speed of the stone when it hits the water?

Answer = ... m/s [2]

(b) Describe the motion of the stone as it falls.

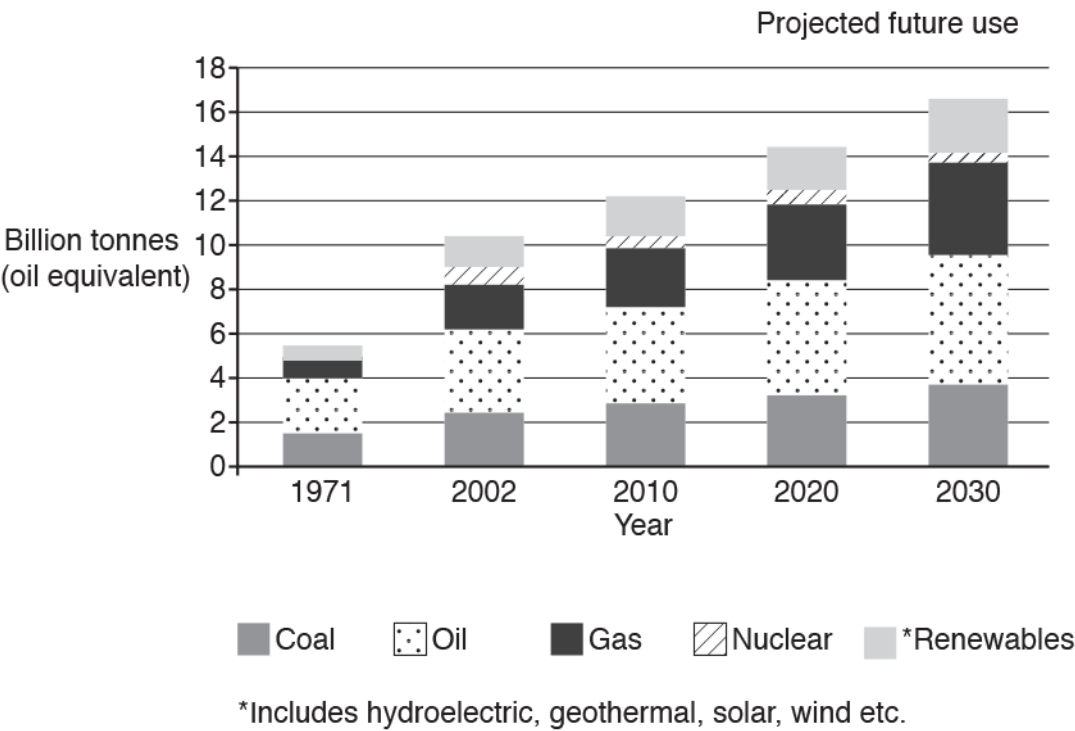
Assume it does not reach terminal velocity.

Use a free body diagram to help you.

[4]

36(a) Scientists are researching the World's energy use for the future.

The graph shows some of their research.



(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1 _____

2 _____

[2]

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to

be built.

Suggest why the government wants more nuclear power stations.

----- [2]

(b) Power stations in the UK generate electricity at 25 kV a.c.

The voltage is then increased to 400 kV a.c. and distributed by power lines.

(i) Write down the full name of the device used to **increase** the voltage.

----- [1]

(ii) Why is it important to increase the voltage in these power lines?

----- [1]

(iii) The high voltages across the power lines are reduced to 230 V a.c. for use in the home.

A phone charger changes the 230 V a.c. to a 5 V d.c.

Explain the difference between d.c. and a.c.

----- [2]

(c) 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 Ω .

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]

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

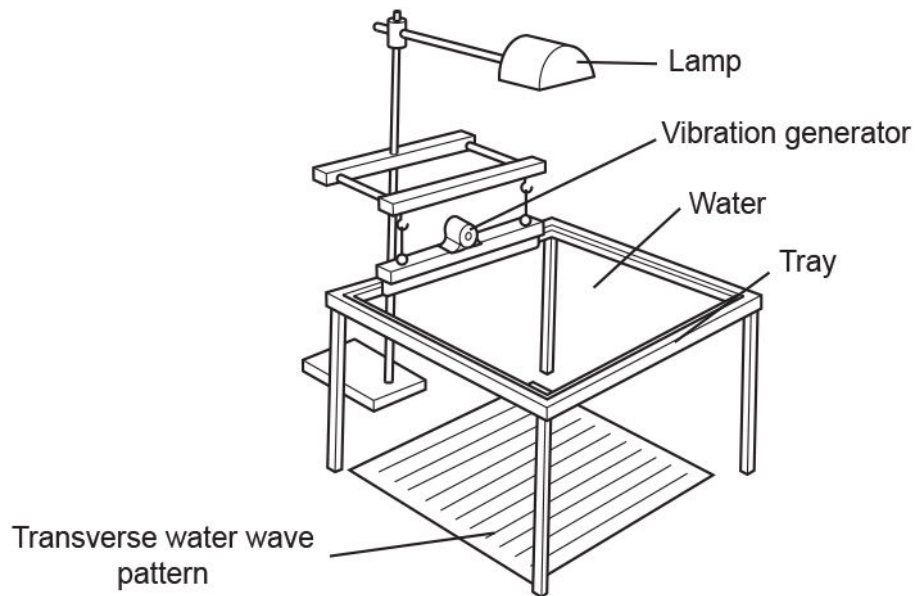
_____ [1]

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

State a reason why.

_____ [1]

37 A teacher uses water waves in a ripple tank to demonstrate **transverse** waves.



She makes measurements of the water waves.

The frequency of the water waves is 0.5 Hz.

(i) Calculate the number of water waves produced in 5 seconds.

Answer = ... [1]

(ii) The teacher **increases** the frequency of the water waves.

Describe what happens to the speed **and** the wavelength of the water waves.

.....

.....

(iii) A student tries to describe water waves in the sea.

'The water waves move up and down. The water particles move all the way across the surface of the sea. This means that water moves in the direction of the waves.'

Part of his explanation is **incorrect**.

Write an improved and correct description about water waves in the sea.

39(a) Carbon is a common element. Carbon has two different isotopes called carbon-12 and carbon-14. Both of these isotopes have six protons in the nucleus.

- (i) Carbon-14 is radioactive and carbon-12 is **not** radioactive.

Explain why some isotopes are radioactive.

----- [1]

- (ii) Describe how the nucleus of carbon-12 is different to the nucleus of carbon-14.

----- [1]

- (b) Decay equations are used to show the type of emission from different radioactive elements.

- (i) Complete the decay equation for **alpha** emission.



- (ii) Complete the decay equation for **beta** emission.



- (iii) Complete the decay equation for **gamma** emission.



40 Some electromagnetic waves are used to scan a person in hospital.

Which statement is true about a scan that uses **electromagnetic** waves?

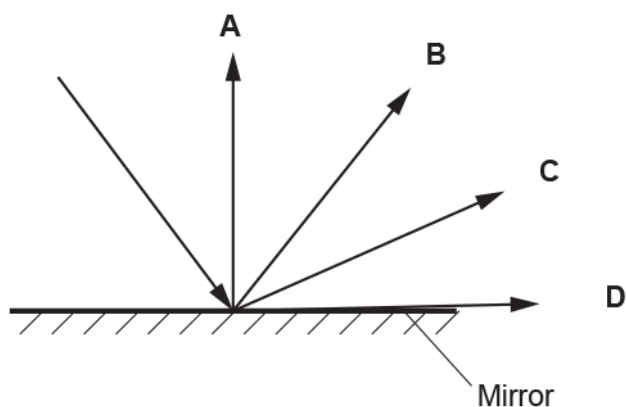
- A Micro-waves are used to scan skin.
- B Ultrasound waves are used to scan an unborn baby.
- C Ultra-violet is used to scan for cancer.
- D X-rays are used to scan for broken bones.

Your answer

☐

[1]

41 Which light ray shows the correct reflection from the plane (flat) mirror?



Your answer

☐

[1]

42 A wooden block has a mass of 2 kg and a specific heat capacity of 2000 J/kg °C.

Calculate the energy needed to raise its temperature by 6 °C.

Use the equation:

Change in thermal energy = Mass × Specific Heat Capacity × Change in Temperature

A 1 200 J

B 2 400 J

C 12 000 J

D 24 000 J

Your answer

[1]

43 Water waves are transverse and sound waves are longitudinal.

(i) Describe how water particles move in a **transverse** water wave.

----- [1]

(ii) Describe how air particles move in a **longitudinal** sound wave.

----- [1]

44 A lorry has a mass of 3500 kg. It travels at a speed of 30 m/s.

Use the equation: Kinetic Energy = $0.5 \times \text{Mass} \times \text{Speed}^2$

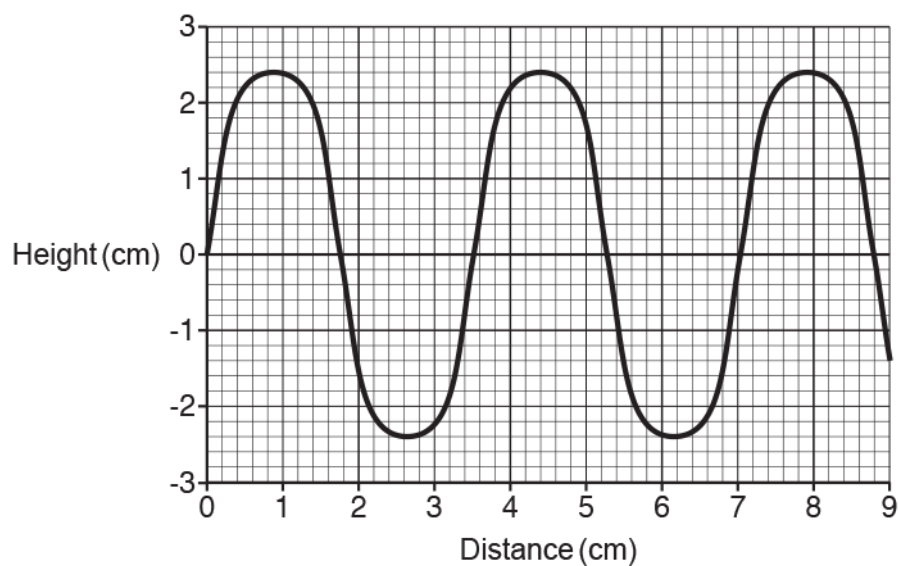
Calculate the kinetic energy of this lorry.

- A 10 500 J
- B 52 500 J
- C 1 575 000 J
- D 3 150 000 J

Your answer

[1]

45(a) Look at the diagram of a water wave.



(i) What is the **wavelength** of this wave?

Answer = ----- cm [1]

(ii) What is the **amplitude** of this wave?

Answer = ----- cm [1]

(iii) The wavelength of the wave is changed to 25 cm. Two waves are produced each second.

Use the equation: Wave speed = Frequency $\times$ Wavelength

Calculate the speed of the wave.

Answer = ----- m/s [2]

(b) Look at the diagram of the electromagnetic spectrum.

Radio	Microwave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
-------	-----------	-----------	---------------	--------------	--------	------------

(i) Name a wave that has a longer wavelength than red light.

-----[1]

(ii) Name a wave that has a higher frequency than violet light.

-----[1]

(iii) State two **uses** of gamma-rays.

1. -----

2. -----

[2]

46(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.

(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]

47

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

* Explain why the stopping distances are different for each speed in Fig. 20.1.

[6]

48(a)

A car has a total weight of 12 000 N. It has four tyres which each have an area of 25 cm² in contact with the road.

Calculate the pressure of the car on the road.

Answer = ... N/cm²

[3]

(b) Seatbelts in cars are made of a wide material that stretches in a crash.



(i) Explain why it is important that the material is **wide**.

.....
..... [1]

(ii) Explain why it is important that the material is **stretchy**.

.....
..... [1]

49(a) A student watches a ball game on the school field.

The student sees the ball being hit with a bat but he hears the sound a short time after. This is because the speed of light is greater than the speed of sound.

He decides to do an experiment to measure the speed of sound waves in air.

Describe which measurements he needs to measure this speed.

----- [2]

(b) Which equation is used to calculate speed?

----- [1]

50 Fig. 20.1 shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

Calculate the reaction time of the person driving the car.

Answer = ----- s [3]

Children in cars use special seats with their own seatbelts.



The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children's seatbelts to be **narrower** than adult seatbelts?

----- [2]

52(a) This question is about force, mass and acceleration.

A car starts from rest and accelerates at 3 m/s^2 .

Use the equation: Acceleration = Change in velocity $\div$ Time taken

Calculate the **velocity** of the car after 4 s.

Answer = ----- m/s [2]

(b) A roller coaster car moves down a slope with an acceleration of 5 m/s².

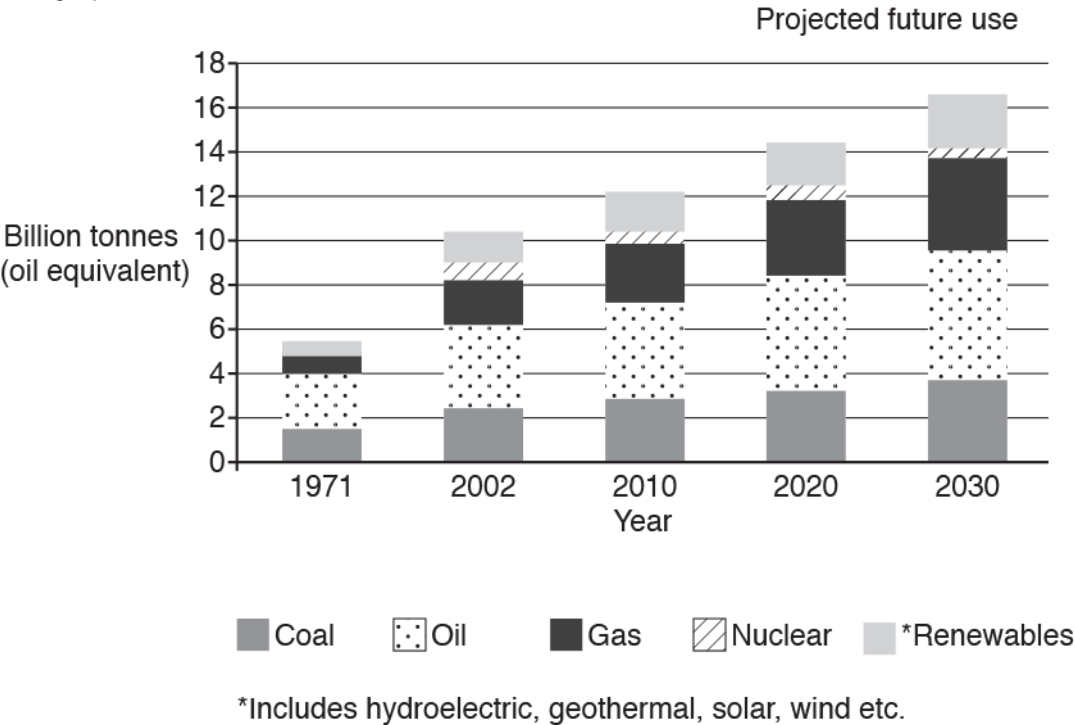
The force on the roller coaster car is 4000 N.

Calculate the mass of the roller coaster car.

Answer = _____ kg [2]

53(a) Scientists are researching the World’s energy use for the future.

The graph shows some of their research.



(i) The future demand for fossil fuels is expected to increase.

Give two reasons why scientists are worried about this increase in demand.

1. _____

2. -----

----- [2]

(ii) In the UK the government is closing coal fired power stations and planning for new nuclear power stations to be built.

Suggest why the government wants more nuclear power stations.

----- [2]

(b) Power stations in the UK generate electricity at 25 kV a.c.

The voltage is then increased to 400 kV a.c. and distributed by power lines.

(i) Write down the full name of the device used to **increase** the voltage.

-----[1]

(ii) Why is it important to increase the voltage in these power lines?

-----[1]

(iii) The high voltages across the power lines are reduced to 230 V a.c. for use in the home.

A phone charger changes the 230 V a.c. to a 5 V d.c.

Explain the difference between d.c. and a.c.

-----[2]

(c) 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 Ω .

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]

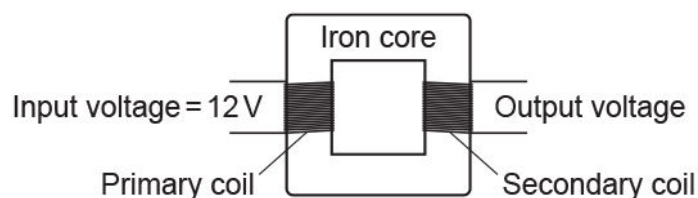
(iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

----- [1]

54(a) A student investigates building model transformers in the laboratory.

Look at the diagram.



The student builds four different transformers, each with different primary and secondary coils.

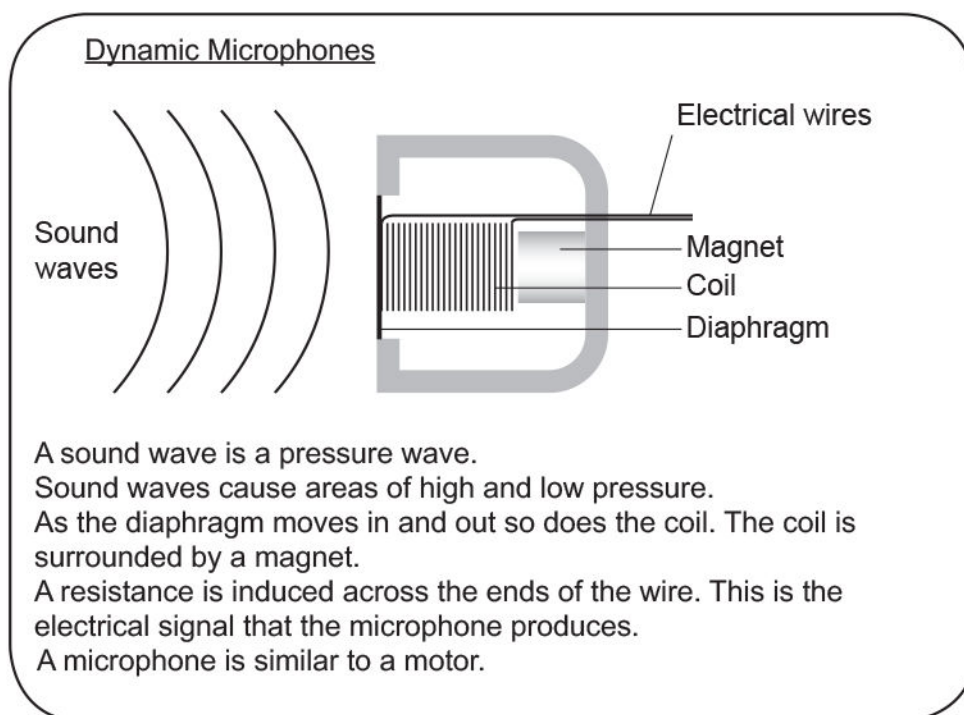
Look at the results.

* Explain how a transformer works and if this data supports the expected output voltages.

[6]

(b) A student completes a project on how dynamic microphones work.

Look at her project. The student uses two incorrect words in her work.



(i) Identify **one** of the incorrect words **and** write a correct sentence to replace the mistake.

Incorrect word

Corrected sentence

.....

[2]

(ii) Name a device which uses this effect in reverse.

.....

[1]

55 A student investigates a gas at **constant volume**.

Explain, using ideas about particles, how temperature affects gas pressure.

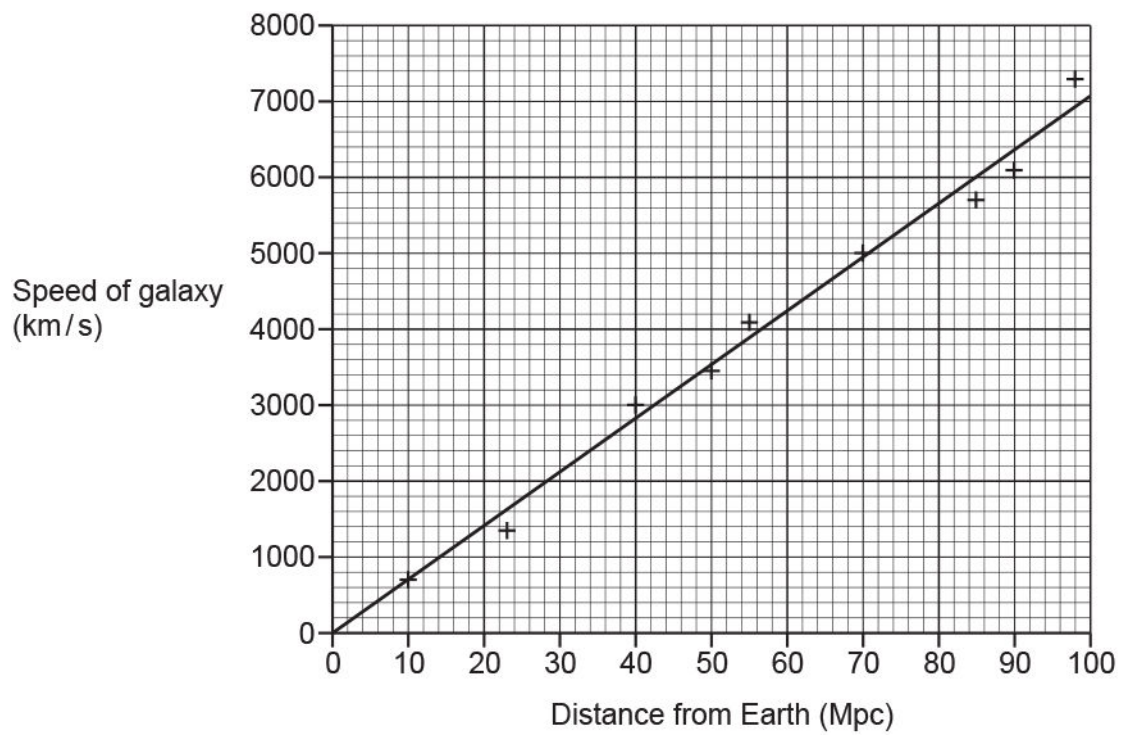
[3]

56(a) Edwin Hubble discovered that all distant galaxies were moving away from the Earth.

Explain how he could tell that all distant galaxies were moving away from the Earth.

[2]

(b) This graph shows how the speed of a galaxy changes with distance from the Earth.



- (i) Use data from the graph to show that the speed of the galaxy is proportional to the distance from the Earth.

[2]

- (ii) Explain how data from the graph provides evidence for the Big-Bang.

[1]

(c) Before Edwin Hubble could publish his results, his work was peer reviewed.

Suggest why peer review is important.

----- [1]

(d) The parsec (pc) is a unit used for measuring large distances in the Universe.

(i) A galaxy is at a distance of 82 Mpc from the Earth.

Use the graph to determine the speed of this galaxy.

Give your answer in metres per second (m / s).

Speed = ... m / s [2]

(ii) Calculate the time it takes for the galaxy to travel 2.53×10^{24} m.

Use your answer to (i) to help you.

Time = ... s [3]

END OF QUESTION PAPER

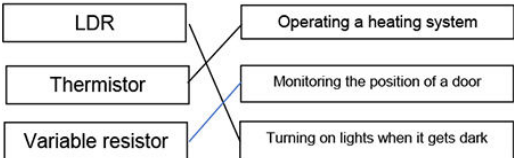
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	any one from so to confirm the experiment is • repeatable / reproducible (1) so other scientists can • (idea of) peer review (1) • check the method (1) • check for mistakes (1) • confirm / re-test / verify / prove / validate results (1) • inform other scientists / people (1) • further-development / research (1) • use the data (1)	1	Allow 'check it' (1)
		ii	any one from scientists have not been able to repeat the claim (1) (seems to) contradict the laws of physics / AW (1) no model that shows that cold fusion is possible (1)	1	allow fusion requires high temperatures / high energy (1) Eg. it does not produce more energy than amount of energy used (1) ignore merely 'no proof' / 'no evidence' / false or fake results
			Total	2	
2			D ✓	1 (AO2.2)	
			Total	1	
3			C ✓	1 (AO2.2)	
			Total	1	
4			D ✓	1 (AO2.1)	<u>Examiner's Comments</u> About two-thirds of the candidates got this question correct: the commonest wrong answer here was A, presumably looking at the symmetry in the bottom part of the diagram.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5			B ✓	1 (AO2.2)	
			Total	1	
6			C ✓	1 (AO2.1)	
			Total	1	
7			D ✓	1 (AO1.2)	
			Total	1	
8			B ✓	1 (AO1.2)	
			Total	1	
9			C ✓	1 (AO2.1)	
			Total	1	
10			B ✓	1 (AO1.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	TV ✓	1 (AO3.2b)	Examiner's Comments Most candidates multiplied the relevant variables (power and time used) in the data table, and used the units Wh or kWh. This was a good approach for questions of this type.
		ii	Light bulb ✓	1 (AO3.2b)	Examiner's Comments Here the appliance with the lowest power rating (light bulb) was the right answer  Misconception The most common misconception was just to compare the power ratings of the appliances and chose the toaster as the answer. Doing some quick calculations of work done and jotting vales next to the table helps answering these types of question. If the power and time for the TV and light bulb had been slightly different it would have given a different answer.
	b			2 (AO 2 × 2.1)	1 mark for each correct link Examiner's Comments Most candidates were credited full marks on this question. Virtually no candidates got one mark, perhaps because this required two components to be used for the same purpose. It was encouraging to see how candidates across the ability range were aware of the use of specific electrical components around their homes.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000 000 (J) award 4 marks Rearrange to energy = charge $\times$ potential difference ✓ 44 000 $\times$ 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ OR Substitute correctly 44 000 (C) = energy $\div$ 230 (V) ✓ Rearrange to energy = 44 000 (C) $\times$ 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above <u>Examiner's Comments</u> There was an erratum with this question to correct the units to joules. The figures in this question were difficult, and many candidates coped well with the large numbers and also the rearrangement of the equation. Some candidates rearranged the equation before substitution and others after. Fewer candidates were able to round 10 120 000 J to two significant figures (e.g. 10 000 000 J).  OCR support Mathematical Skills Handbook http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12		i	Any two from: The old model has no protons / ORA ✓ The old model has no neutrons / ORA ✓ There is no nucleus in the old model / ORA ✓ The electrons are in fixed positions in the old model / ORA ✓ The positive particles are in a nucleus in the current model ✓ The negative particles/electrons are outside / surround the nucleus in the current model ✓	2 (AO2 × 1.1)	<u>Examiner's Comments</u>  Misconception It is important to be clear which model/view point/thing the candidate is writing about in these type of question. Candidates will not be credited when they expect the examiner to interpret what their answer implies. It is better to state clearly "the old model." rather than "one of the models ..." A number of candidates read the first statement about the old atomic model as implying that atoms had a positive charge. Several candidates did not achieve both marks because they were not clear about which model they were talking about.
		ii	Any two from: new evidence ✓ more experiments completed ✓ previous model couldn't explain new observations ✓	2 (AO2 × 1.1)	ALLOW mention of Rutherford, Geiger/Marsden <u>Examiner's Comments</u> Most candidates recognised the role of Rutherford/Geiger/Marsden which was expected. Several candidates mentioned Niels Bohr and/or John Dalton, which was unexpected in this context.
			Total	4	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
13	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description and comparison of the motion of all four students in terms of distance and time relating speed to distance run AND Calculates the speed of all four students. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description and comparison of the motion of three students of distance and time OR Calculates the speed of at least three students. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Brief description of the motion of at least three students. OR Calculates the speed of at least one student. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 (AO2 × 1.1) (AO2 × 2.2) (AO1 × 3.1a) (AO1 × 3.2b)	AO1.1 Demonstrate knowledge and understanding of the correct formulae • speed = distance ÷ time • $v = s \div t$ • evidence of calculation AO2.2 Apply knowledge and understanding of the motion of the four students • Race B is a longer distance than race A • Race B and C are the same distance • Students B & C take different amounts of time • Student D takes the longest time • Race D is the longest distance • Race A is the shortest distance • Student A speed = $15 \div 6 = 8.3\text{m/s}$ • Student B speed = $100 \div 15 = 6.7\text{m/s}$ • Student C speed = $100 \div 14 = 7.1\text{m/s}$ • Student D speed = $200 \div 31 = 6.5\text{m/s}$ AO3.1a & AO3.2b Analyse information to interpret and draw conclusions about the motion of the four students • Race B is twice the length of race A, but time is more than twice that of race A • C is faster than B as the time is shorter (for the same distance) • As race length increases, average speed decreases <u>Examiner's Comments</u> There were many excellent answers, with the mean speeds of all four runners calculated with comments about how they had run different races (apart from B and C). Many candidates helped themselves by annotating the calculated speeds next to

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			the table). The most able candidates discussed the effect of running a longer race on the mean speed of the runner (see Exemplar 7 below). Less able candidates compared the times of each runner but did not calculate speeds (see Exemplar 5 below).  OCR support About one in ten candidate did not attempt to answer this question. Level of Response (LoR) questions are designed to open up the potential answers so that candidates at all levels of ability have an opportunity to show their scientific understanding. Every candidate should be encouraged to answer LoR questions as even a weak but relevant answer will be credited. The 'How to answer 6 mark LoR questions' resource can be used to help candidates prepare for this style of question http://www.ocr.org.uk/Images/374902-how-to-answer-6-mark-lor-activity.doc Exemplar 5 Use the information in the table to describe and compare the motion of the four students. Use the data in your answer. The less motion the student had completed the race quicker as to student A the race distance is 50m then did the race in 6s and student D the race resistance was 20.0 and did the race in 31s. However student B and C race resistance was the same ^{15m} and student B did the race in 15s and C did the race in 14s. [6] A Level 1 candidate response. They describe the data in the table with no attempt to process data and calculate the speed of each runner. The information is relevant to the question but there is no real attempt to compare the motion of the four students.

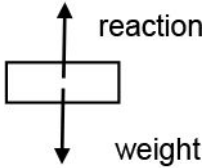
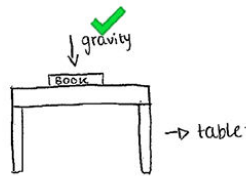
Mark Scheme

Question	Answer/Indicative content	Marks	Guidance																				
			Exemplar 6 Use the information in the table to describe and compare the motion of the four students. Use the data in your answer. Student A raced 50 m in 6s which means they were racing at roughly 8.3 m/s. This shows that their motion of this student is very fast. Students B and C ran 100m. However, student B ran 100m in 15 seconds while student C ran 100m in 14 seconds. This shows that student B was a slower motion than student C. Student D races 200m in 31 seconds, which is around 6.5 m/s. This shows that the motion of student A is slower than the motion of student D. A Level 2 candidate response. They have calculated and compared the speeds of A and D, but only compared the relative motions of B and C. There is a structured line of reasoning and the reporting of data is linked by sentences that offer some interpretation of the facts. Exemplar 7 <table border="1"> <thead> <tr> <th>Student</th><th>Race distance (m)</th><th>Time (s)</th><th>Speed = $\frac{\text{distance}}{\text{time}}$</th></tr> </thead> <tbody> <tr> <td>A</td><td>50</td><td>6</td><td>8.3 m/s</td></tr> <tr> <td>B</td><td>100</td><td>15</td><td>6.6 m/s</td></tr> <tr> <td>C</td><td>100</td><td>14</td><td>7.1 m/s</td></tr> <tr> <td>D</td><td>200</td><td>31</td><td>6.5 m/s</td></tr> </tbody> </table> Use the information in the table to describe and compare the motion of the four students. Use the data in your answer. From looking at the table student A covered the smallest distance of 50m in the smallest time of 6s but at the greatest speed of 8.3 m/s. Students B and C both covered 100m during the race but student C was one second quicker than student B ($15 - 14 = 1\text{ s}$). Therefore student C had a greater speed of 7.1 m/s compared to student B at 6.6 m/s. Even though student D covered the largest overall distance of 200m they moved at the smallest speed of 6.5 m/s. This could be due to the fact student D took the largest amount of time of 31s. A Level 3 candidate response. They first calculated the speed of each student and then annotated the data table. This allowed them to be more focused and precise in their response. They have offered some explanation of the relative motions of the students. This answer is logical and all the content is relevant. The word counts for all	Student	Race distance (m)	Time (s)	Speed = $\frac{\text{distance}}{\text{time}}$	A	50	6	8.3 m/s	B	100	15	6.6 m/s	C	100	14	7.1 m/s	D	200	31	6.5 m/s
Student	Race distance (m)	Time (s)	Speed = $\frac{\text{distance}}{\text{time}}$																				
A	50	6	8.3 m/s																				
B	100	15	6.6 m/s																				
C	100	14	7.1 m/s																				
D	200	31	6.5 m/s																				

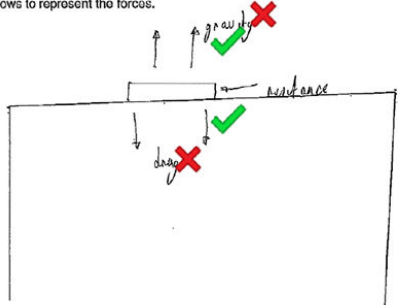
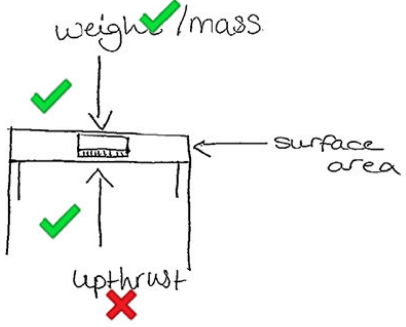
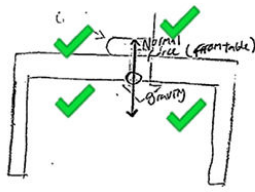
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					three exemplars are similar and demonstrating that a well thought out answer is better than a very long answer.
			Total	6	

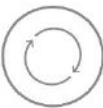
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a		Two arrows drawn of equal length ✓ One up and one down ✓ The downwards arrow labelled weight/gravity ✓ The upwards arrow labelled contact/reaction force ✓	4 (AO4 × 2.1)	e.g.  Examiner's Comments The best answers were offered by candidates who drew diagrammatic side view of a book on a table with opposing vertical forces shown by arrows pointing outwards from the centre of the book (see exemplar 11 below). Many candidates had drawn vertical arrows of equal length with the downward force labelled 'gravity' (see exemplars 8 and 9), the use of the correct force "weight" was rare (see exemplars 10 and 11). Fewer candidates labelled the counter-force 'reaction' or 'contact force'. The position of the arrows emanating from a point/box representing the centre of mass of the book was not an enforced marking point. Exemplar 8 Use arrows to represent the forces.  Exemplar 9 [4]

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			Use arrows to represent the forces.  [4] Exemplar 10  [4] Exemplar 11  [4]
b i	$F = ma$ / force equals mass times acceleration ✓ so reducing mass means the same engine force will cause greater acceleration ✓	2 (AO1.2) (AO2.2)	Must start with Newton II NOT less force for same acceleration Examiner's Comments Few candidates identified that this question was about the implications of the equation $F = ma$. Candidates did not recognise that the force would be the same for both the heavier and the lighter model of car. Most candidates discussed the effects of friction

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			on the car. For the order of magnitude for changes in mass between different models of a car frictional forces would have no measurable effect on acceleration. Exemplar 12 (i) Explain why the presenter is correct. ...if the car is heavier the weight on the wheels can affect the acceleration. If the mass is less there will be less weight on the wheels so the acceleration will be better. A This answer only considers the marginal changes in friction caused by a very small increase in the contact area of the tyres but ignores the more significant effect that the same force applied to a smaller mass will have on acceleration. Exemplar 13 (i) Explain why the presenter is correct. As Force = mass x acceleration. Equal force ÷ mass = acceleration. Signifying a smaller mass will mean faster acceleration. ✓ BDD ...the car is less massive. ✓ BDD This candidate's answer shows very clearly why using a more mathematical approach in physics saves time and increases understanding. They have identified the appropriate equation ($F=ma$), changed the subject to acceleration and then drawn the correct conclusion. Using this approach their answer was shorter, clearer and more relevant than exemplar 12.  AFL As a starter exercise show students the question and ask them to select the equation that will answer the question. Helping students to be more comfortable using equations will help them overcome their reluctance to answer physics questions using maths.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 (m/s²) award 3 marks change in speed = $25 - 5 = 20$ (m/s) ✓ acceleration = $20 \div 4$ (m/s²) ✓ = 5 (m/s²) ✓	3 (AO2.1) (AO2.1) (AO2.1)	e.c.f. incorrect change in speed if subtraction attempted <u>Examiner's Comments</u> This calculation was well done with most candidates being credited with all three marks.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15		i	moment = force $\times$ distance ✓ clockwise moment = 800 (Nm) ✓ anti-clockwise moment = 1000 (Nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 2 marks (total) if clockwise and anti-clockwise moments are reversed Correct calculation of either moment implies correct equation so gets m.p.1 also <u>Examiner's Comments</u> Some candidates were confused as to the direction of rotation of 'clockwise' and 'anticlockwise', so credit was allowed to those who reversed their sense. Many candidates did not know how to calculate a moment, although this could be deduced from the units provided in the answer line (telling them to multiply the two). The unit Nm is the product of the force (N) and the distance (m) of each child from the pivot point of the seesaw.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.6 (m) award 3 marks (anti-clockwise moment) 500 (N)$\times$distance = 800 (N m) ✓ distance = 800 $\div$ 500 ✓ = 1.6 (m) ✓	3 (AO1.2) (AO2.2) (AO2.2)	E.c.f. clockwise moment from (a)(i) for 800 (N m) If child B chosen, giving 1000 $\div$ 400 = 2.5 (m), award 2 marks (loses m.p.1) <u>Examiner's Comments</u> Many candidates did not identify that the command word "calculate" was asking them to provide a mathematical solution rather than a qualitative descriptive of where child A should sit. Several candidates did calculate the correct answer and showed their workings in the space provided.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks $0.25 \times 16 \checkmark$ 4 (V) $\checkmark$	2 (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Most candidates were successfully completed the calculation.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks $P = IV \checkmark$ $P = 0.25 \times 4 \checkmark$ $P = 1 \text{ (W)} \checkmark$ OR $P = I^2 R \checkmark$ $P = 0.25^2 \times 16 \checkmark$ $P = 1 \text{ (W)} \checkmark$	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci <u>Examiner's Comments</u> A quarter of all candidates calculated the correct answer here. Very few of the other candidates recognised that (c)(i) and (c)(ii) were a developing story and so did not multiply the answer to the first part of the question (4 V) by 0.25 A to calculate the answer to the second part.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force ÷ area ✓ = 10 ÷ 0.1 ✓ = 100 (Pa)✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Many candidates were not able to recall the equation $P = F/A$. Some candidates did recall the equation and correctly calculated the pressure in the fluid as 100 Pa. A common misconception was using the equation $P = F \times A$ to calculate the pressure as 1 Pa.
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	ALLOW to the left opposite to the force from the plunger <u>Examiner's Comments</u> Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	4	
18			always points to North / South ✓✓ OR Points to (magnetic) North / South ✓ line up with the magnetic field lines of the Earth ✓ OR Compass needle shows (an angle of) dip ✓ Dip (angle) changes (from equator) ✓	2 (AO2 ×1.1)	ALLOW Points North/South wherever you are ✓✓ <u>Examiner's Comments</u> This was a challenging question for candidates. This question asks about a quite separate behaviour of a magnetic compass in the Earth's magnetic field. Wherever you might happen to be on the surface of the Earth a magnetic (dipping) compass will always point north (or south). There were very few candidates who referred to the angle of dip in the direction of the north (or south) magnetic pole. Or that at the magnetic poles a dipping compass dips vertically downward towards the core of the Earth.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19			C ✓	1 (AO1.1)	<u>Examiner's Comments</u> The great majority of candidates gave the correct answer C.
			Total	1	
20			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> About 80% of candidates gave the correct answer A. Common incorrect answers were randomly selected from the other distractors.
			Total	1	
21			D ✓	1 (AO1.2)	<u>Examiner's Comments</u> About two thirds of candidates gave the correct answer D. A common incorrect response was 'C'.
			Total	1	
22			B	1 (AO2.1)	<u>Examiner's Comments</u> This was the first calculation on the paper and about 80% gave the correct answer B. A common incorrect response was 'A', presumably due to confusion over clockwise and anticlockwise.
			Total	1	
23			D ✓	1 (AO1.1)	<u>Examiner's Comments</u> This was well known by nearly all candidates who gave D as their answer.
			Total	1	
24			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> About 40% of the candidature gave the right answer A. The common incorrect response was usually 'D'.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
25			D ✓	1 (AO2.2)	<u>Examiner's Comments</u> This calculation was answered successfully by about three quarters of the candidates stating D.
			Total	1	
26			C ✓	1 (AO2.2)	<u>Examiner's Comments</u> About half of the candidates could correctly calculate the distance travelled from the graph (by area or calculation) and gave C as the answer. Working out was often seen on this question and answer D was a frequently chosen distractor (velocity × time, $8 \times 5 = 40\text{m}$).
			Total	1	
27			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> In this calculation about a third of candidates gave the correct answer A. The other distractors were randomly selected.
			Total	1	
28			C ✓	1 (AO2.1)	<u>Examiner's Comments</u> About two thirds of candidates gave the correct answer C.
			Total	1	

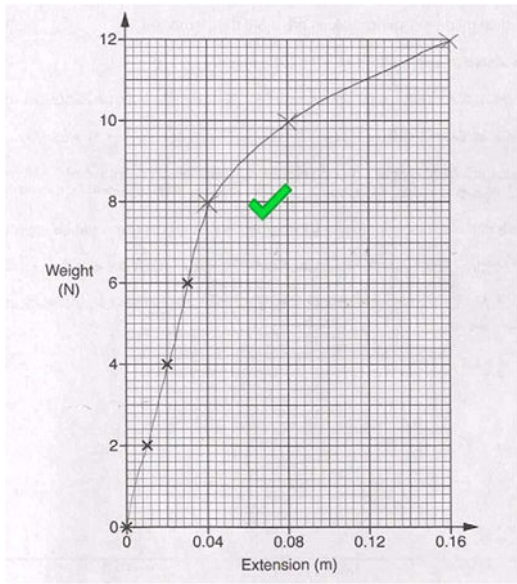
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks $0.25 \times 16 \checkmark$ 4 (V) $\checkmark$	2 (AO2.1) (AO2.1)	<u>Examiner's Comments</u> This standard demand Ohm's law calculation was very well answered by almost all candidates. As, on this occasion, the formula was given in the question then the mark total was limited to 2 marks.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks $P = IV \checkmark$ $P = 0.25 \times 4 \checkmark$ $P = 1 \text{ (W)} \checkmark$ OR $P = I^2 R \checkmark$ $P = 0.25^2 \times 16 \checkmark$ $P = 1 \text{ (W)} \checkmark$	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci <u>Examiner's Comments</u> About two thirds of candidates gained all 3 marks here for the calculation on power.
			Total	5	
30			always points to North / South $\checkmark\checkmark$ OR Points to (magnetic) North / South $\checkmark$ line up with the magnetic field lines of the Earth $\checkmark$ OR Compass needle shows (an angle of) dip $\checkmark$ Dip (angle) changes (from equator) $\checkmark$	2 (AO2 $\times 1.1)$	ALLOW Points North / South wherever you are $\checkmark\checkmark$ <u>Examiner's Comments</u> Most candidates gained 1 mark for the idea of pointing north. Better answers (about a third) stated that the compass always pointed north and gained both marks. There were very few answers referring to the angle of dip.
			Total	2	

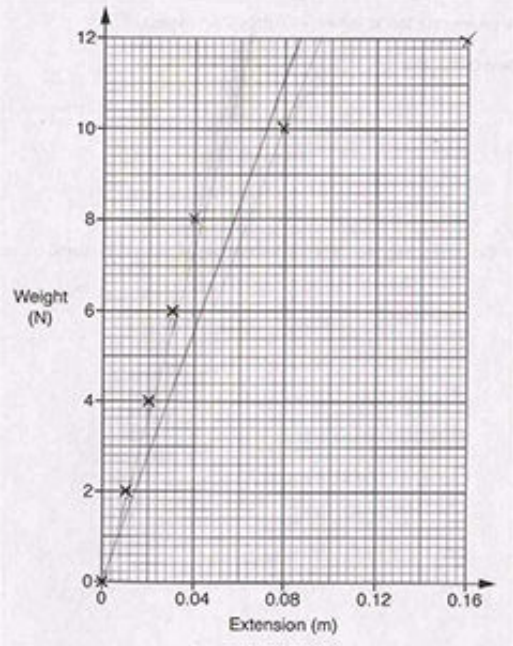
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
31		i	potential difference ✓ closed or complete circuit ✓	2 (AO2 × 1.1)	IGNORE ions / charge ALLOW voltage ALLOW higher level answers eg. must have delocalised electrons / electrons that are free to move <u>Examiner's Comments</u> Only about 10% here gained both marks. Delocalised electrons was a common correct answer for 1 mark. Less often seen were a potential difference [1] and a complete circuit [1].
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1500 (C) award 4 marks $Q = It$ ✓ $t = 5 \times 60 = 300 \text{ (s)}$ ✓ $Q = 5 \times 300$ ✓ $Q = 1500 \text{ (C)}$ ✓	4 (AO1.1) (AO2.1) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> This was reasonably well answered and about two thirds of candidates gained 3 marks for 1500. Some forgot to convert minutes to seconds but were credited some reward for their working.
			Total	6	

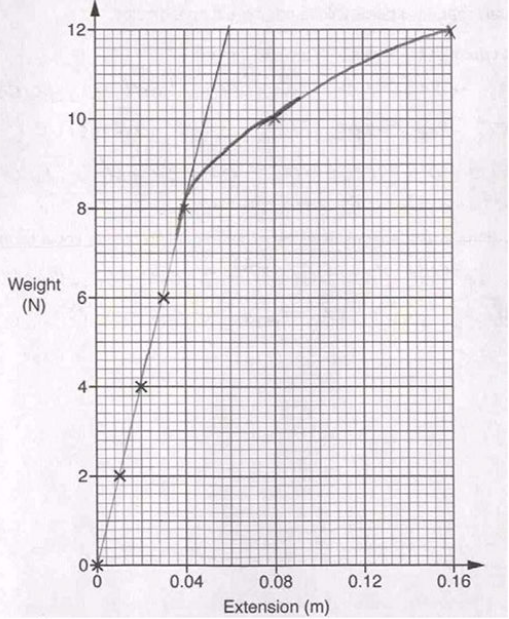
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
32	a	i	All three points correctly plotted ✓✓ OR two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / – ½ square or less (by eye) <u>Examiner's Comments</u> All the points were usually plotted correctly.
		ii	straight line up to 0.04, 8 and curved line consistent with points plotted past this point ✓	1 (AO 3.1a)	ALLOW ecf from part ai for misplotted points ALLOW straight part of graph drawn without ruler. DO NOT ALLOW dot-to-dot for curve Single line should be thin (less than ½ square thick) and continuous to gain the mark. <u>Examiner's Comments</u> Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve. Exemplar 1  This gets full marks for both parts as the answer shows accurate plotting for part i of

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable. Exemplar 2  This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks. Exemplar 3

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			 This shows two lines, one curved and one straight. The marker cannot give credit as they are unsure which one to mark. In any case the curved line would have been too thick to award the mark as it is thicker than half a square.
iii	Initially the extension increases steadily / linearly / uniformly / (directly) proportionally / elastically / AW ✓ (then the) wire reaches its elastic limit ✓ the extension increases plastically / by more for each (2N) weight added (past this point) / AW ✓	3 (AO 3.1a) (AO 1.2) (AO 3.1a)	ALLOW gradient is steady up to 8N ALLOW initially obeys Hooke's law IGNORE limit of proportionality (as this is an AO3 answer for an AO1 question) ALLOW Hooke's law not obeyed after 8N <u>Examiner's Comments</u> This gave a good range of marks with most describing the first stage as extension is linear or proportional. Some clearly referred to elastic limit [1 mark] although vague answers such as 'limit of proportionality' was frequently seen [0 mark]. Some were successful in describing the extension after the limit is reached.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 (N/m) award 3 marks $k = F \div x$ ✓ $k = 6 \div 0.03$ ✓ (or equivalent correct expression from 0 to 6N) $k = 200$ (N/m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE $F=kx$ Substitution into correctly rearranged formula ✓✓ <u>Examiner's Comments</u> This calculation, like many on the paper was answered well. Here about third quarters of answers gained all three marks. For unsuccessful calculations however, 1 mark was given for the correct rearrangement of the formula $k = F \div x$.
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.16 (J) award 2 marks $E = 0.5 \times 200 \times 0.04^2$ ✓ $E = 0.16$ (J) ✓	2 (AO 1.2) (AO 2.1)	ALLOW ecf from part b ALLOW area under graph method: $0.5 \times 8 \times 0.04$ ✓ BUT area under graph method used to calculate 0.16 scores ✓✓ <u>Examiner's Comments</u> Most candidates incorrectly used 'work done = force $\times$ distance' giving the answer 0.32 (J). Better answers used $E = 0.5 \times 200 \times 0.4^2$ to successfully get 0.16 (J) and gained full marks.
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
33			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 380 000 (J) award 3 marks SLH = $E \div m$ ✓ = $95000 \div 0.25$ ✓ = 380000 (J/kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	Rearranging equation $95 \div 250$ or 0.38 scores ✓ (evidence of rearranged formula) $95\ 000 \div 250 = 380$ scores ✓✓ Or $95 \div 0.25 = 380$ ✓✓ Or 380 ✓✓ <u>Examiner's Comments</u> Slightly over a half gained all 3 marks for this calculation. Some gained fewer marks because of power of 10 errors in conversions for example 360 [2] rather than 360 000 [3]. Others gained [1] for the correct rearrangement of the formula.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
34	a		momentum ✓ kinetic energy or KE ✓	2 (AO 2 × 1.1)	IGNORE mass conserved If more than two answers mark the first two answers (unless one of them is mass). Eg 'KE, mass, momentum' ✓✓ Eg. PE, KE, momentum ✓ <u>Examiner's Comments</u> Kinetic energy and momentum were the answers here. Full marks (in 10% of cases) were attained by more able candidates only. Just less than a half gained 1 mark only. 'Energy' or 'potential energy' (rather than kinetic energy) was often seen along with mass, velocity.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINES If answers = 8.4 (kgm/s) and 6.75 / 6.8 (kgm/s) award 3 marks 2 × 4.2 2.5 × 2.7 ✓ A: 8.4 (kgm/s) ✓ B: 6.75/6.8 (kgm/s) ✓	3 (AO 1.2) (AO 2.2) (AO 2.2)	8.4 and 6.7 scores ✓✓ (incorrect rounding of one of the values) <u>Examiner's Comments</u> The great majority calculated both values of momentum correctly and gained 3 marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.4 (m/s) award 3 marks $(8.4 + 6.75) \times 4.5 \checkmark$ $3.37 / 3.366666667 \text{ (m)} \checkmark$ 3.4 (rounding to 2 sf) $\checkmark$	3 (AO 2.2) (AO 2.2) (AO 1.2)	ECF for momentum values eg. $(A + B) \div 4.5$ Wrong answer but evidence of correct rounding $\checkmark$ Eg. 6.75 to 6.8 $\checkmark$ <u>Examiner's Comments</u> Just under a half of candidates calculated this correctly to two significant figures. About a third did gain any credit at all and gave attempts of calculations that were incorrect or difficult to follow.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
35	a	i	initial speed is zero and • either acceleration due to gravity = 10 • or $g = 10 \checkmark$ use $a = (v-u) \div t$ to find the final speed / $v \checkmark$ use $v^2 - u^2 = 2as$ to find $s \checkmark$	3 (AO 3 × 1.1)	IGNORE the idea of echoes and speed of sound ALLOW answers using $g = 9.8$ or 9.81 ALLOW $v = u + at \checkmark$ ALLOW credit for higher level answers: Eg. three marks for answer in terms of $s = ut + \frac{1}{2}at^2$ <u>Examiner's Comments</u> This was an intentionally challenging question where less than 10% did not score at all. Most of these wrote about $g = 10$ and the initial velocity was 0 and gained 1 mark. Very few successfully continued further.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 22 (m/s) award 2 marks $10 = v (- 0) / 2.2$ OR uses idea that stone gains 10m/s each second $\checkmark$ $V = 22$ (m/s) $\checkmark$	2 (AO 2 × 2.1)	ALLOW 21.56 or 21.58 or 21.6 (if $g=9.8$ or 9.81) $\checkmark\checkmark$ <u>Examiner's Comments</u> Again this challenging calculation saw about 1/5th gaining both marks with 22 (m/s). A few correctly used $g = 9.8$ or 9.81 and still scored full marks. Many used speed = distance ÷ time and did not score.

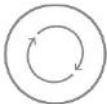
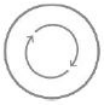
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		only 2 arrows drawn or directions of the two forces described – one upwards and one downwards ✓ Correctly names weight and air resistance / drag ✓ downward arrow longer than upward arrow / forces are unbalanced / resultant / net / overall force downwards ✓ so object accelerates / gets faster / increases velocity or speed ✓	4 (AO 2.1) (AO 1.1) (AO 2.1) (AO 1.1)	Award marks for answer points given in diagrams or prose. ALLOW force of gravity or mg or gravitational pull for weight BUT DO NOT ALLOW merely 'gravity' IGNORE upthrust for this marking point only Drag / air resistance  (3 marks) Weight or force of gravity <u>Examiner's Comments</u> There were some good answers here. A common error was to state 'gravity' rather than weight or force of gravity. The relative sizes of the arrows were often correct. Upthrust was often unsuccessfully substituted for air resistance. The question discriminated well with about a third gaining full marks.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
36	a	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO3.1b) (AO3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO₂ / carbon emissions IGNORE just pollution or bad for the environment / more CFCs <u>Examiner's Comments</u> This question assessed AO3 and the majority of candidates gained at least 1 mark, usually for the idea that fossil fuels are not renewable. A significant number of candidates did not gain the second mark as their responses included statements about pollution that were too vague e.g. 'harmful emissions' or 'bad for the environment'. Exemplar 2 1. Fossil fuels are non-renewable and will eventually run out ✓ 2. Fossil fuels release lots of pollution, which causes damage to people and the planet [2] This response was credited with 1 mark for stating that fossil fuels are renewable. The second mark was not achieved as the candidate's statement that 'fossil fuels release lots of pollution' is not specific enough. To gain the second mark, the candidate should have referred to an appropriate scientific reason, for example more CO₂ or more greenhouse gases.

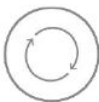
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	2 (AO1.2) (AO1.2)	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs <u>Examiner's Comments</u>  Although many candidates achieved 1 or 2 marks, a significant proportion did not gain any credit. Some candidates had the misconception that nuclear power is renewable. Others gave vague suggestions about 'damage to the environment'. Only the highest ability candidates usually gained full credit.  AfL Candidates should be aware that in a Physics exam what they write will be assessed as a specific scientific response. Where candidates use unnamed, vague statements about 'pollution' or 'damage to the environment' these are unlikely to gain credit. For example graffiti, fly tipping and loud music are examples of pollution that are unlikely to be caused a power station.
	b	i	Step-up transformer ✓	1 (AO1.1)	<u>Examiner's Comments</u> The majority of candidates correctly identified a step-up transformer. However, many lower ability candidates had less secure knowledge and suggested an inappropriate electrical device such as a voltmeter.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Reduce energy wastage / loss ✓	1 (AO1.1)	ALLOW less heat loss / reduce current / reduce power loss / more useful power out / more efficient / less heating of wires DO NOT ALLOW no energy losses / prevent energy loss / AW <u>Examiner's Comments</u> This question is a direct assessment of on specification knowledge (P8.2d and P8.2e) that is in both separate Physics and Combined Science. However candidates across the ability range found it challenging and a minority of candidates correctly answered this lower demand question.  Misconception Candidates have many misconceptions about transformers and why the voltage needs be increased. They referred to many incorrect ideas such as to make the energy move faster / further, to transfer enough power to homes and to reduce the resistance. Some candidates suggested that high voltages are used in the National Grid as this reduces energy losses during transmission to zero.  OCR support There is a KS3–KS4 Transition Guide (J249) and a KS4–KS5 Transition Guide (H557) that offer support on teaching about generation of and distribution of the domestic electrical supply: http://www.ocr.org.uk/Images/324646-electricity-ks3-ks4-transition-guide.pdf http://www.ocr.org.uk/Images/309732-generating-electricity-transition-guide.pdf

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	d.c – (current / voltage / charge flow / it) has one direction or polarity ✓ a.c.- (current / voltage / charge flow / it) (continually) changes direction or polarity ✓	2 (AO1.1) (AO1.1)	ALLOW dc only positive / only negative IGNORE electricity ALLOW current / voltage alternates OR positive and negative <u>Examiner's Comments</u> Most candidates gained at least 1 mark, usually for identifying a.c. as alternating current. Common misconceptions for d.c. included 'd.c. is constant' or 'd.c. goes straight to the device'.
	c	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 <u>Examiner's Comments</u> 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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					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 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	14	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37		i	2 ½ or 2.5 ✓	1 (AO1.2)	Examiner's Comments Most candidates were able to calculate the number of waves produced. The most common error made was to divide the time by the frequency instead of multiplying the time by the frequency.
		ii	Speed is unchanged / stays the same ✓ Wavelength reduces ✓	2 (AO2.1) (AO2.1)	Answer must indicate idea of speed Answer must indicate idea of wavelength IGNORE answers that merely state 'no change and reduces' Examiner's Comments Most candidates correctly stated that the wavelength would decrease. The majority of candidates stating that wave speed would also increase while only the highest ability candidates knew that that wave speed would be unchanged.
		iii	Any two from: Water / particles move up and down / oscillate vertically ✓ Water / particles move at 90° / perpendicular to the direction of wave (travel) / AW ✓ Energy moves in direction of the wave (travel) / AW ✓	2 (AO2 × 2.1)	IGNORE any statements that are just repeated from the question. IGNORE water waves move up and down ALLOW energy moves at 90° to wave vibrations / movement ✓✓ Examiner's Comments Candidates found this question very challenging and many misinterpreted what they were being asked to do. Most candidates did not identify that the second and third statements about water wave were incorrect and many merely rewrote the student's original statement. The most common mark gained was for the idea of the water moving perpendicular to the direction of the wave motion. Only the highest ability candidates gained full credit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	5	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
38	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) A detailed explanation of how ultrasound and X-rays are used. AND A detailed evaluation of the risks / benefits of using the two different waves to scan patients in hospital, which may include use of information from the table. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) An explanation of how ultrasound and X-rays are used. AND An evaluation of the risks / benefits of using the two different waves to scan patients in hospital. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) EITHER An explanation of how ultrasound and X-rays are used. OR An evaluation of the risks / benefits of using the two different waves to scan patients in hospital. OR An explanation of ultrasound or X-rays AND an evaluation of the risks / benefits of ultrasound or X-rays. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks - No response worthy of credit.	6 (AO2 × 1.2) (AO1 × 2.2) (AO1 × 3.1b) (AO2 × 3.2a)	AO1.2 Demonstrate knowledge and understanding of X-rays and ultrasound • X-rays show bone • Ultrasound shows eg soft tissue / kidneys/ blood flow / prenatal scan AO2.2 Applies knowledge and understanding of X-rays and ultrasounds • X-rays damage / ionise living cells / causes cancer / damage foetus • Ultrasound is harmless AO3.1b Analyses information to evaluate the differences in X-rays and ultrasound • X-rays are absorbed by bone but do not show up soft tissues • Ultrasound is (partially) reflected for soft tissues only AO3.2a Analyses information to make judgements about the risks and benefits: • Ultrasound always safe and useful for soft tissue scanning • X-rays can cause cancer but save lives with identifying bone problems • X-rays have a frequency greater than 3×10^{16} Hz / (very small) wavelengths less than 10 nm to penetrate the body <u>Examiner's Comments</u> This Level of Response question assessed all three Assessment Objectives and provided an opportunity for candidates to demonstrate Grade 9 performance. Most candidates gained some credit for their written responses. The majority demonstrated a good knowledge of X-rays in particular and two thirds of the candidates demonstrated Level 2 or Level 3 performance. Many excellent responses at Level 3 included detailed explanations of absorption of X-rays by bones, reflection of ultrasound for soft tissues, and a detailed

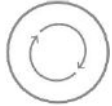
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					evaluation of the risks and benefits of the two different waves.  Most responses successfully identified the risks / benefits of X-rays but a common misconception was that ultrasound could also cause cell mutations or harm (to the baby).  Misconception Most candidates successfully identified the risks and benefits of X-rays but a significant number of candidates mistakenly believed that ultrasound could also cause cell mutations or harm to the baby. Exemplar 4 18. (d) Ultrasound waves are used to look at a live image of soft tissues within the body such as a foetus by measuring the time it takes for the wave to return when it reflects at the border of a membrane. This process is beneficial as it can produce a live feed of the inside of the body and also it is completely harmless as it is only a sound wave as it is above 2MHz a human can't hear it and so it doesn't affect our hearing. However, it can only produce a black and white image and it can only detect soft tissues so X-rays are used. X-rays are high energy Electromagnetic waves that potentially pose a large risk of ionisation and cancer in patients so exposure is limited and the technicians and doctors are protected by a lead wall to absorb any radiation as the high frequency of $>3 \times 10^{16}$ Hz means it is high energy and could penetrate through thin materials. The X-rays are passed through the body and where there is bone they are absorbed and so do not reach the film behind the person and so these parts stay white and the X-ray that reach it turn the film black to leave an image of bones which is useful to see broken bones but is expensive compared to ultrasound and also produces a black and white image but most importantly is dangerous and so needs to be limited where as ultrasound is harmless. This is a six mark, Level 3 answer. The candidate included a detailed explanation of how both X-rays and ultrasound are used to scan patients. There is also a detailed evaluation of risks / benefits of both waves, which includes the use of some data from the table.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
39	a	i	(Radioactive nuclei) are unstable ✓	1 (AO1.1)	ALLOW (nuclei have) too many neutrons <u>Examiner's Comments</u> Just over half of the candidates correctly explained that some isotopes are radioactive because the nuclei are unstable or have too many neutrons. Common incorrect responses referred to 'more neutrons' or ideas about numbers of electrons or protons.
		ii	Different numbers of neutrons ✓	1 (AO1.1)	<u>Examiner's Comments</u> The majority of candidates successfully stated that there are a different number of neutrons in carbon-12 and carbon-14.
	b	i	${}^{226}_{90}\text{Th}$ ✓	2 (AO2.2) (AO2.2)	
		ii	${}^0_{-1}\beta$ ✓	2 (AO2.2) (AO2.2)	
		iii	${}^{235}_{92}\text{U} \rightarrow \gamma + {}^{235}_{92}\text{U}$ ✓	2 (AO2.2) (AO2.2)	<u>Examiner's Comments</u> Almost all candidates were able to complete all three decay equations. Of the small number who could not complete the equation the most common error was stating the atomic number of beta as +1 rather than -1.
			Total	8	
40			D ✓	1 (AO 1.1)	<u>Examiner's Comments</u> This question was generally answered well. The common incorrect answer was B, where candidates thought that ultrasound was an electromagnetic wave.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
41			B ✓	1 (AO 1.1)	Examiner's Comments This question was generally answered well. Some candidate incorrectly selected either A the normal or C.  AfL With ray diagrams, candidates should always identify the normal, before working out further positions of the rays.
			Total	1	
42			D ✓	1 (AO 2.1)	Examiner's Comments Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	1	

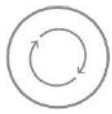
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
43		i	(Particles move) up and down / oscillate/vibrate vertically/at right angles to the direction of the wave ✓	1 (AO 1.1)	
		ii	(Particles move) forwards and backwards / oscillate/vibrate parallel to the direction of the wave / AW ✓	1 (AO 1.1)	Examiner's Comments Very few candidates were able to express a clear understanding of the motion of particles caused by the progress of a transverse water wave, or a longitudinal sound wave. A number of candidates stated used ambiguous descriptions such as 'the particles would move side to side', which could apply to both transverse and longitudinal waves.  OCR support The Waves in Matter transition guide (from KS3 to KS4) provides guidance on the teaching about waves. http://www.ocr.org.uk/Images/318139-waves-in-matter-transition-guide.pdf
			Total	2	
44			C ✓	1 (AO 2.2)	Examiner's Comments Candidates were required to carry out a simple substitution into a given equation were generally answered well. The most common error was not squaring the speed and choosing distractor B.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
45	a	i	3.5 (cm) ✓	1 (AO 1.1)	ALLOW 3.4 to 3.6 Examiner's Comments One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response was 9 cm.
		ii	2.4 (cm) ✓	1 (AO 1.1)	Examiner's Comments Many candidates read the vertical axis incorrectly and gave values that were around 2.4 cm but not that specific value (for example 2.5 cm).  Misconception A common incorrect answer was 4.8 cm, where candidates confused the peak to peak value with amplitude. Other candidates confused amplitude with the wavelength.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (m/s) award 2 marks 2×25 OR 2×0.25 ✓ 0.5 (m/s) ✓	2 (AO 2 x 2.1)	ALLOW 50 Examiner's Comments Most candidates were credited with one mark for multiplying 2 by 25 to give an answer of 50. Fewer candidates appreciated that this was 50 cm/s while the unit on the answer line was m/s.  AfL Encourage candidates to check the unit used on the answer line. This additional information can help them to understand the question and the equations they should use.
	b	i	Radio / infra-red / microwave ✓	1 (AO 1.1)	
		ii	Ultra-violet / X-rays / gamma-rays ✓	1 (AO 1.1)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	Any two from: Radiotherapy / killing cancer cells ✓ Irradiating food / sterilisation of instruments✓ Tracer / medical imaging✓ Scanning metals / non-destructive testing (NDT) ✓	4 (AO2.1)	ALLOW tumours / treatment of cancer ALLOW killing bacteria / (harmful) microorganisms / sterilising food <u>Examiner's Comments</u> Candidates had a sounder understanding of the trend in frequency in the electromagnetic spectrum (part ii) than that for wavelength (part i). The most common misconception was by candidates who gave visible light as their response to both part i and part ii. Around half of the candidates knew that gamma-rays are used in the treatment of cancer but other uses, such as the irradiation of food or medical equipment, were known by far fewer. To gain credit, candidates need to ensure that their answers are specific. A number of candidates stated that gamma-rays were used in chemotherapy. Some candidates stated that gamma-rays were used in scans, often with an implication of unborn babies. It was hoped that candidates would understand the use of gamma radiation as a tracer and for sterilising instruments.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
46	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 <u>Examiner's Comments</u> 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 <u>Examiner's Comments</u> 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
47	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Explains quantitatively why the stopping distances are different for each speed in the table in terms of braking distance and thinking distance. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Explains qualitatively why the stopping distances are different for each speed in the table in terms of braking distance or thinking distance increasing with speed from the table <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) States basic ideas about thinking distance / braking distance / stopping distance OR identifies variation of thinking distance / braking distance / stopping distance with speed <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks - No response or no response worthy of credit.	6 (AO 2 x 1.1) (AO 2 x 2.1) (AO 2 x 3.2b)	AO1.1a Demonstrates knowledge and understanding of thinking, braking and stopping distance • Thinking distance is the distance the car travels while the driver reacts • Braking distance is the distance travelled while the brakes are applied • Stopping distance is thinking distance + braking distance AO2.1 Applies knowledge and understanding of thinking, braking and stopping distance in relation to the details in the table • Increasing the speed, increases the thinking distance • Increasing the speed, increases the braking distance • Increasing the speed, increases the stopping distance AO3.2b Analyses information to make judgements and draw detailed conclusions from table • Thinking distance is directly proportional to the speed • When speed doubles, thinking distance doubles • Braking distance is proportional to speed² • When speed doubles, braking distance quadruples Examiner's Comments This question gave candidates the opportunity to apply their knowledge and understanding of stopping distances. The question is deliberately set to be open ended so that candidates had the opportunity of structuring their answers logically. Higher ability candidates explained that the stopping distance was equal to the sum of

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			the thinking distance and braking distance before stating that the stopping distances increased with speed. Often candidates demonstrated the change in stopping distance using the data from the table. For the highest marks, candidates were expected to analyse the data quantitatively from the table. A few candidates used part (a) and stated that thinking distance doubled with speed and carried out a similar analysis for braking distance, stating that as speed doubled, braking distance quadrupled. Common misconceptions included thinking time increasing with speed, drivers being under greater pressure at high speed, braking forces increasing with speed. Other candidates discussed factors that affected thinking distance and braking distance rather than using the data in the table. Exemplar 2 (c)* Explain why the stopping distances are different for each speed in Fig. 20.1. When driving at 8 m/s the thinking and braking distance are equal, 6m. Therefore the stopping is $6 \times 2 = 12\text{m}$. When driving at 16 m/s the thinking distance double but it takes longer to break as your going at a faster speed. Some applies to 32 m/s as it takes 90m longer than 8 m/s to stop. Meaning the stopping distance totals 120m. This is a four mark, Level 2 response. The candidate has calculated the stopping distance for each speed and provided a limited analysis. They have made good use of mathematical expressions to show that stopping distance is equal to the product of thinking and breaking distance. The information presented is relevant, however there are limited links made between the bullet points. To progress to a Level 3 response the candidate could have added a short introduction and a final bullet point linking the analysis at each speed together

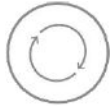
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					in a summary sentence. Exemplar 3 (c)* Explain why the stopping distances are different for each speed in Fig. 20.1. At higher speeds the thinking and braking distance increases. If the speed doubles the thinking distance doubles and the braking distance quadruples. This means the stopping distances get larger. The thinking distances increase because the car is travelling at a higher speed meaning it will travel further in that thinking time which stays the same. The braking distance increases massively with faster speed. This is because there is a higher velocity and a larger moment therefore it takes a lot more force and time to decelerate the car. What is shown in the graph is that this equates to a much longer a difference in stopping time because of these two factors, which caused by the different speeds. This is a six mark Level 3 response. This is very clear analysis of the data in the table that is linked together in a clear logical structured way. Although the candidate has not annotated their script (except in their response to (a) it is clear that they have processed the data in the table. They have described the complex mathematical relationships (for example 'if the speed doubles the thinking distance doubles and the breaking distance quadruples') although it would have been easier to present this conclusion numerically.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
48	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm²) award 3 marks Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000 ÷ 25 ✓ = 120 (N/cm²)	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 12000÷25 for one mark ALLOW for two marks 480 (N/cm²) <u>Examiner's Comments</u> Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm².

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1 (AO 1.1)	Examiner's Comments Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.  AfL The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	1 (AO 1.1)	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop Examiner's Comments Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	5	
49	a		Distance (between source and observer) ✓ Time (for sound to travel between source and observer) ✓	2 (AO 2 x 1.1)	Do not accept distance / time the ball travels Do not accept metres / seconds Examiner's Comments Some candidates wrote a list of quantities that could be measured with no description: speed, distance, time, frequency and wavelength. These candidates could not be credited with any marks as they had not answered the question. Candidates were expected to describe how the distance that the sound would travel and the time for the sound to travel were needed to calculate the speed. Many candidates ignored the context for the question and referred to measuring the distance the ball travels.
	b		Speed = distance ÷ time ✓	1 (AO 1.1)	ALLOW distance ÷ time Examiner's Comments This question was answered well by candidates. Some candidates quoted the wave equation which was not appropriate to the experiment. A significant number of candidates incorrectly gave the correct equation as <i>speed = distance × time</i>..
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
50			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.75 (s) award 3 marks Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 or 12÷16 or 24÷32 ✓ = 0.75 (s) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE correct substitutions if NOT rearranged Examiner's Comments 10% of candidates recalled the speed equation and rearrange it as <i>reaction time = thinking distance ÷ speed</i>. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.
			Total	3	
51			Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2 (AO 2.1) (AO 1.1)	ALLOW weight of child is lower/child is smaller Examiner's Comments Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
52	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (m/s) award 2 marks Rearrange formula - 4×3 ✓ 12 (m/s) ✓	2 (AO 2.1) (AO 2.1)	Examiner's Comments Higher ability candidates wrote out in a recognisable form that <i>change in velocity = acceleration × time</i> = $3 \times 4 = 12$ (m/s). A common misconception was to divide the acceleration by time taken (i.e. $3 \times 4 = 0.75$). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 800 (kg) award 3 marks Recall: force = mass × acceleration ✓ $4000 \div 5$ ✓ 800 (kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 0.8 for two marks Examiner's Comments Some candidates divided their calculated answer by 1000 so that their answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
53	a	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO 3.1b) (AO 3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO₂ / carbon emissions IGNORE just pollution or bad for the environment / more CFCs <u>Examiner's Comments</u> Most candidates recognised that fossil fuels may run out or be in short supply or stating that they are non-renewable. However, fewer candidates went on to give specific scientific reasons for scientists concerns that were creditable. Most candidates gave generalised responses about fossil fuels damaging the environment or causing 'pollution'.
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	2 (AO 1.2) (AO 1.2)	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs <u>Examiner's Comments</u> Higher ability candidates said that there were not enough renewable energy resources and nuclear power stations would assist in meeting the demand for electricity, or help in preserving fossil fuels. Answers which gave detail about less damage to the environment were also credited, although a number of candidates thought that nuclear power stations would not cause any potential damage to the environment.

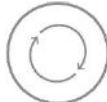
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Step-up transformer ✓	1 (AO 1.1)	Examiner's Comments One in six candidates did mention transformers. Step-up and step-down transformers are on specification knowledge (P8.2d) and candidates should know the difference that step-up transformers are used to increase the voltage distributed by power line.
		ii	Reduce energy wastage / loss ✓	1 (AO 1.1)	ALLOW less heat loss / reduce current / reduce power loss / more useful power out / more efficient / less heating of wires DO NOT ALLOW no energy losses / prevent energy loss / AW Examiner's Comments This question required candidates to apply their understanding of the National Grid from P8.2e. Only the most able candidates recalled that the higher voltage reduces energy losses but does not eliminate them. Some candidates stated that higher voltages allowed more power to be produced.
		iii	d.c – (current / voltage / charge flow / it) has one direction or polarity ✓ a.c.- (current / voltage / charge flow / it) (continually) changes direction or polarity ✓	2 (AO 1.1) (AO 1.1)	ALLOW dc only positive / only negative IGNORE electricity ALLOW current / voltage alternates OR positive and negative Examiner's Comments Only the most able candidates were able to answer this question explaining both the differences in the direction of the current flow and the polarity of the voltage. Misconception Most candidates' knowledge and understanding of a.c. and d.c. electrical supply is quite vague, and often only understood in terms of 'different directions' but not how this relates to the flow of current nor to the polarity of the voltage.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	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	14	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
54	a	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed explanation about how a transformer works. AND A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Simple explanation of how a transformer works. AND A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. OR Detailed explanation about how a transformer works. AND A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple explanation of how a transformer works. OR A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. OR	6 (AO1.1x3) (AO3.1ax2) (AO3.2ax1)	AO1.1 Demonstrates knowledge and understanding of scientific ideas to give an explanation of how a transformer works For example: • Alternating current / ac / voltage / potential difference • (induces) (alternating) pd / current in secondary • Linking different numbers of coils to changing potential differences (or currents) • More secondary coils = bigger output potential difference • Alternating current in primary coil induces alternating magnetic field in the iron core • Alternating magnetic field in the iron core induces alternating potential difference in the secondary coil • An alternating current flows if the output is connected to a circuit • Ratio of potential differences depends on ratio of coils • Step up transformers increase potential difference and have more secondary coils ORA AO3.1a Analyse information and ideas to interpret – quantitative • Correct equation selected from data sheet • Data from table processed • For A and C expect secondary pd of 24 V • For B and D expect secondary pd of 6 V AO3.1a Analyse information and ideas to interpret - qualitative For example: • Double the number of secondary coils (compared to primary) and the output potential difference is doubled (compared to input) • Halve the number of secondary coils (compared to primary) and the output potential difference is halved

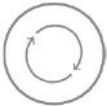
Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		(compared to input) • In transformer A the number of coils increases by 100% and the voltage increases by almost 100%/AW • In transformer B the number of coils decreases by 50% and the voltage decreases by 50%/AW • In transformer C the number of coils increases by 100% and the voltage increases by almost 100%/AW • In transformer D the number of coils decreases by 50% and the voltage decreases by 50%/AW AO3.2a Analyses information and ideas to make judgements • Data supports the expected output voltages • Energy losses in A and C • B and D are efficient ALLOW voltage for potential difference and vice versa <u>Examiner's Comments</u> This question gave candidates the opportunity to apply their knowledge and understanding of the operational of a transformer and to demonstrate that they are able to use the equation linking number of turns and potential difference given on the data sheet. The question is open ended so that candidates have the opportunity of demonstrating their knowledge as well as having the opportunity to structure their answers logically. The question required candidates to explain the operation of the transformer. Most candidates were able to select an appropriate equation from the data sheet and discuss the meaning of step-up and step-down transformers in terms of the turns ratio and the p.d. ratio. Few candidates mentioned that transformers worked on a.c. or clearly

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			explained the alternating magnetic field in the iron core of the transformer inducing an alternating p.d. across the secondary coil. For the highest marks, it was expected that clear calculations for each of the four transformers would be shown with a comment as to whether they supported the theoretical predictions. Many candidates did not show any working. There was also the opportunity to discuss energy losses in transformers particularly about transformer A and transformer C. Exemplar 4 A transformer can either increase or decrease the voltage depending whether it is a step-up transformer or a step-down transformer. The input voltage in the primary coil allows a current to flow and a current through a wire creates a magnetic field which is trapped in the iron core. The secondary coil is created cutting magnetic field lines so through the process of electromagnetic induction an induced potential difference is created along both sides of the coils. The induced potential difference depends on the number of turns in the secondary coil. The formula $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ shows the voltage in primary coil / voltage in secondary coil = Number of turns in primary coil / Number of turns in secondary coil. Therefore the expected output voltage in attempt 63 and attempt 64 are not correct. However the output voltage in attempt 64 and 65 are correct and should be 220V according to this formula. doesn't support the how a transformer works as the output voltage is expected to be 240V, not 220V. This candidate has written a plan of how they intend to answer the question. The initial part of the plan explains how the transformer works. The candidate includes the alternating current, the alternating magnetic field in the iron core and the alternating p.d. induced across the secondary coil. The candidate then discusses step-up and step-down transformers. Before using the data, an equation is given with each of the symbols defined. Working is then shown for the four transformers with a reason why the step-up transformers do not agree with the predicted data. This candidate's response demonstrates a detailed explanation of how the transformer works and there is a quantitative line between the coils and potential difference

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					ratios in relation to the expected output voltages. This is a Level 3 response. The response has a well-developed line of reasoning which is clear and logically structured and the information is relevant so this candidate is given six marks.  AFL Candidates should practice explaining physics concepts.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	Incorrect word (A) resistance (is induced across the ends of the wire) ✓ Corrected sentence (A) potential difference/voltage (is induced across the ends of the wire) ✓ OR Incorrect word (A microphone is similar to a) motor ✓ Corrected sentence (A microphone is similar to a) generator ✓	2 (AO2.1 x2)	ALLOW current is induced ALLOW dynamo Examiner's Comments A large number of candidates correctly identified that "resistance" was incorrect. Many realised that a potential difference is induced across the ends of the wire. The Examiners on this occasion also allowed a current is induced across the end of the wire. Other candidates identified "motor" as incorrect and substituted "generator" in the sentence A significant number of candidates stated that pressure was incorrect and re-wrote the sentence with longitudinal. A few candidates replaced "similar" with "not similar" which did not gain credit.
		ii	Loudspeaker/speaker/headphones ✓	1 (AO1.1)	IGNORE phone Examiner's Comments Most candidates stated speaker(s). It is important that candidates stated a relevant device as opposed to an appliance such as a phone.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
55			For an increase in temperature / heating of gas: gas particles / molecules / atoms have a higher (average) speed / more (kinetic) energy OR A✓ They collide more frequently / often with the walls (of container) / container AW✓ Bigger force (over same area) equals greater pressure ✓	3 (AO3 x1.1)	Direction of temperature change must be clear ALLOW move faster for higher (average) speed ALLOW linked to increase/decrease of KE if temperature change not explicit ALLOW bigger change in momentum <u>Examiner's Comments</u> There were a range of marks in this question. Candidates needed to be able to explain either how an increase in temperature affects the gas pressure or a decrease in temperature affects the gas pressure. The direction of the temperature change needed to be clear. Most candidates realised that an increase in temperature resulted in the gas molecules having more kinetic energy and thus a higher average speed. Candidates were then expected to state that the molecules collided more frequently with the walls of the container. Often, "frequently" was omitted from candidates' answers. The final mark was for stating that the more frequent collisions resulted in a large force over the same area which causes a greater pressure. Some candidates correctly explained the larger force in a greater rate of change of momentum.  AfL Candidates should be encouraged to practise explaining physics concepts in terms of the effect of increasing a quantity on another quantity.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
56	a		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2 (AO2 × 1.1)	ALLOW (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	b	i	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2 (AO2 × 3.1a)	ALLOW +/- ½ a small square ALLOW a statement for the second mark e.g. as the distance doubles so does the speed. <u>Example:</u> At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s $40/20 = 2 = 2800/1400$ ALLOW 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		ii	Any one from: The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1 (AO1.1)	ALLOW galaxies are moving away from each other
	c		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1 (AO1.1)	ALLOW check validity / for mistakes/anomalies / AW ALLOW check that it's not biased / AW
	d	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 800 000 (m/s) award 2 marks (Reads off speed from graph =) 5800 (km/s) ✓ Speed = $5800 \times 1000 = 5\,800\,000$ (m/s) ✓	2 (AO2.2) (AO1.2)	ALLOW 5.8×10^6 (m/s) ALLOW ecf for their speed from graph x 1000

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.36×10^{17} (s) award 3 marks time = distance / speed ✓ (time =) $2.53 \times 10^{24} / 5\,800\,000$ ✓ (time =) 4.36×10^{17} (s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf from (i) ALLOW 4.4×10^{17} (s) ALLOW equation in any form
			Total	11	