

PHYSICS



EXAM QUESTION PACK

M3 ALGEBRA

SCORE

/232

PERCENTAGE

%

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Gateway Physics A (9-1)

Maths 3: Algebra

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	
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Centre number						Candidate number				
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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

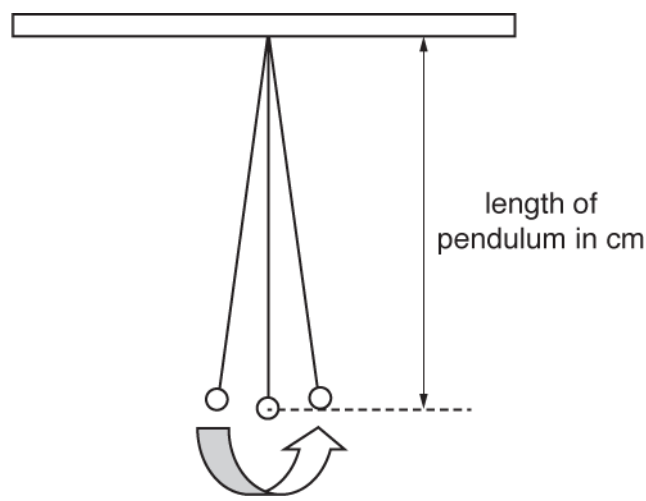
- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist 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 **232**.
- The total number of marks may take into account some 'either/or' question choices.

1(a) Helen investigates children’s swings.

She models the swings in the laboratory using weights attached to a string.

This type of swing is called a **pendulum**.

She sets up a pendulum and makes it swing.



Helen uses a pendulum that has a length of 60 cm.

She measures the time it takes the pendulum to complete 10 swings.

She repeats this three times, **A**, **B** and **C**.

Look at her results.

Length of pendulum in cm	Time for 10 swings in s			
	A	B	C	Mean (average)
60	16.35		15.65	16.00

The results table is incomplete.

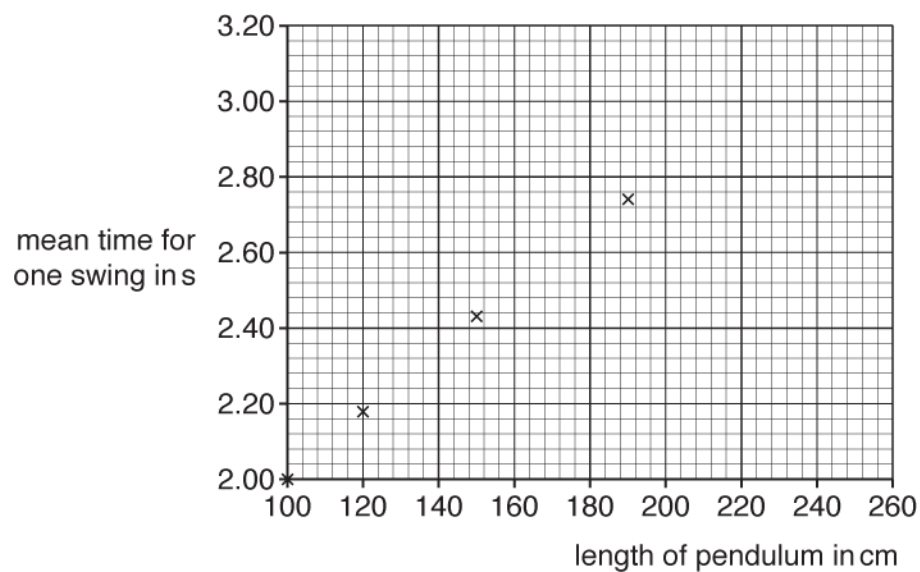
Use the data to calculate the missing value **B**.

answer _____ s [2]

(b) Helen wants to find out about real swings, like those used by children.

She uses longer pendulums and investigates the effect of changing the length.

Look at the graph of Helen's results.



Helen wants to make a pendulum that takes 3 s for one complete swing.

Predict the length of this pendulum.

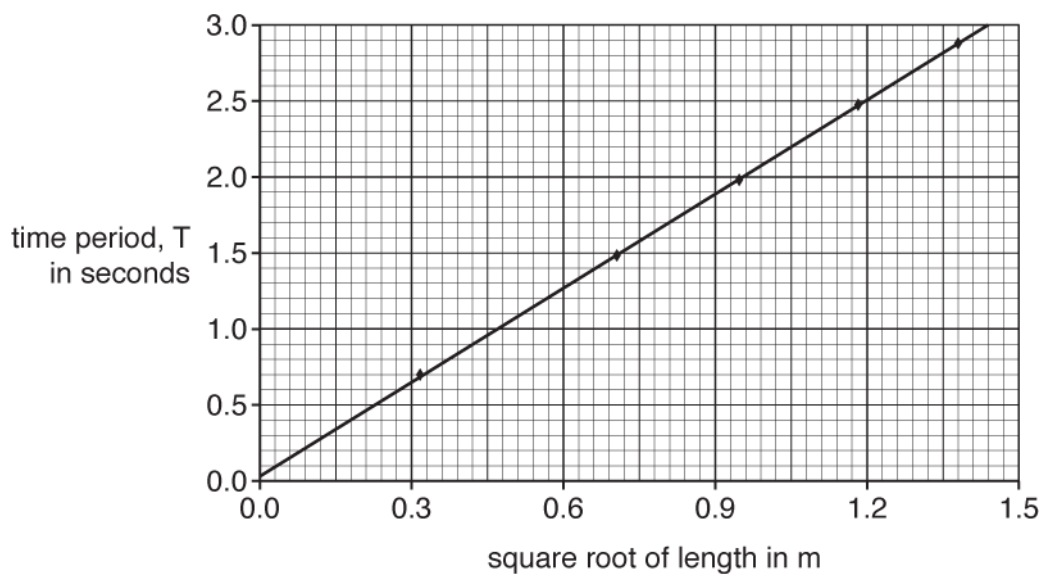
Show your working on the graph.

answer _____ cm [2]

(c) Helen collects more results using a pendulum.

She processes her results.

Look at her graph.



(i) Describe the relationship shown in the graph.

----- [1]

(ii) Helen does some research.

She finds out this information:

- the time it takes for one complete swing is called the time period, T .
- $g = 10 \text{ m/s}^2$ (the acceleration due to gravity)
- L = the length of the pendulum
- $\pi = 3.142$

Helen finds an equation which describes the behaviour of pendulums.

$$T = 2\pi \sqrt{\frac{L}{g}}$$

She wants to find the time period, T for a longer swing.

Calculate the time period for a swing that is 3 m long.

Give your answer to one decimal place.

answer _____ s. [3]

(iii) Helen needs to make a swing with a time period, T , of 1 second.

Calculate the length of a pendulum with a time period of 1 second.

answer _____ m. [2]

- 2 An object travelled 800 m in 40 seconds.

Use the equation: distance travelled (m) = speed (m/s) $\times$ time (s)

What is the speed of the object?

- A 0.05 m/s
- B 20 m/s
- C 840 m/s
- D 32 000 m/s

Your answer

[1]

- 3 An object moved 20 cm with a force of 20 N.

Use the equation: work done = force $\times$ distance

Which is the correct calculation of work done?

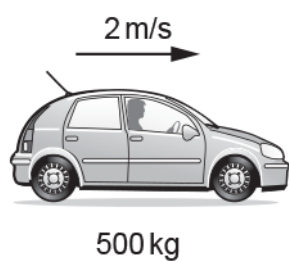
- A 0.4 J
- B 4.0 J
- C 40 J
- D 400 J

Your answer

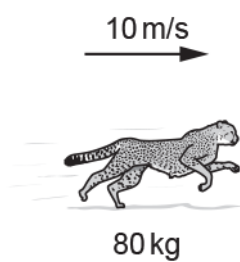
[1]

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

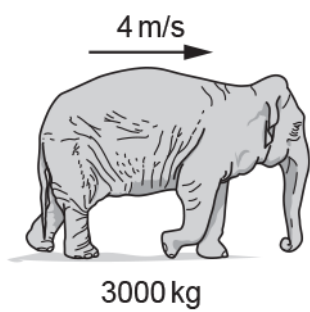
A



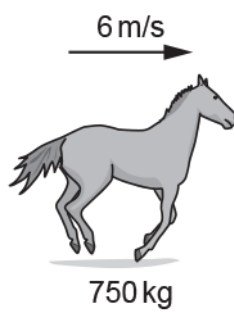
B



C



D



Your answer

[1]

5 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]

6

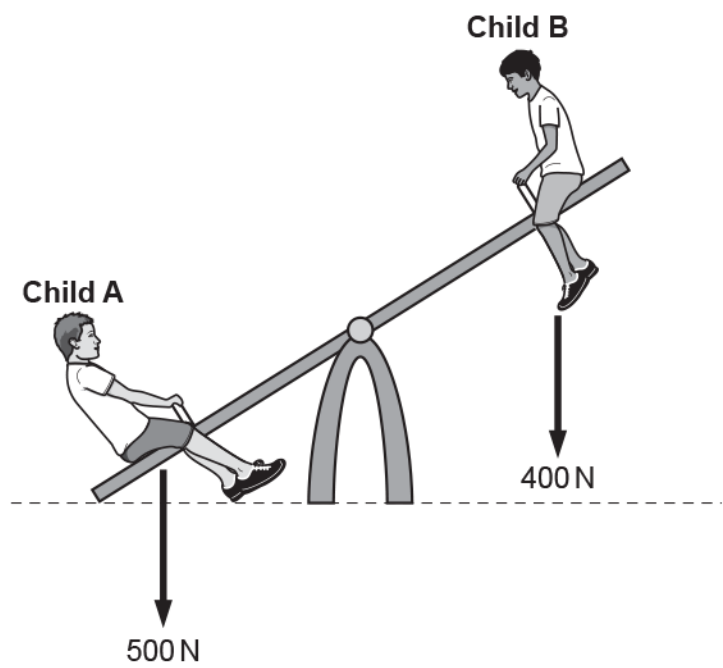
Student	Race distance (m)	Time (s)
A	50	6
B	100	15
C	100	14
D	200	31

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

Use the data in your answer.

[6]

7(a) 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.

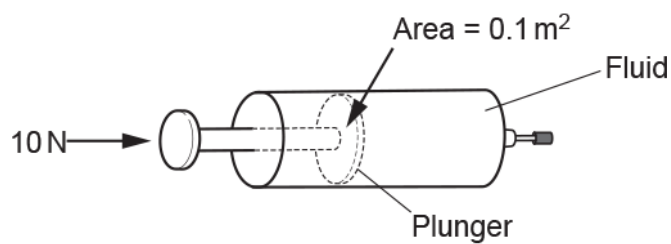
Clockwise moment = ... Nm

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

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

Answer = ... [3]

(b) 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 m^2 .

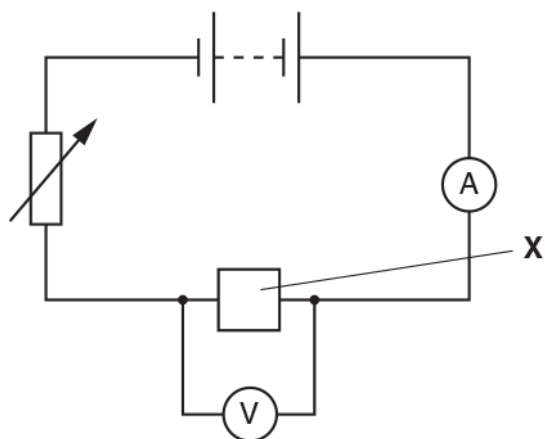
(i) Calculate the pressure in the fluid.

Answer = ... Pa [3]

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

----- [1]

- 8 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.

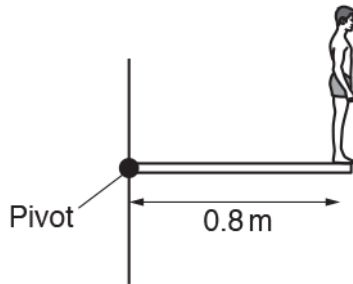
Use the equation: Potential difference = Current $\times$ Resistance

Answer = ... V [2]

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

Answer = ... W [3]

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



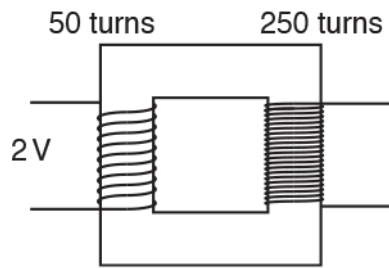
What is the moment of the force provided by the diver around the pivot?

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

Your answer

[1]

10 What output voltage does the transformer produce?



A 0.2 V

B 0.4 V

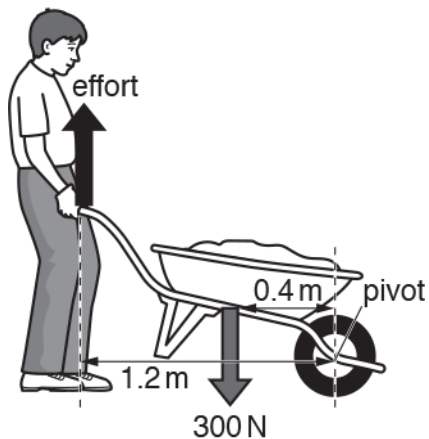
C 5 V

D 10 V

Your answer

[1]

11 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]

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

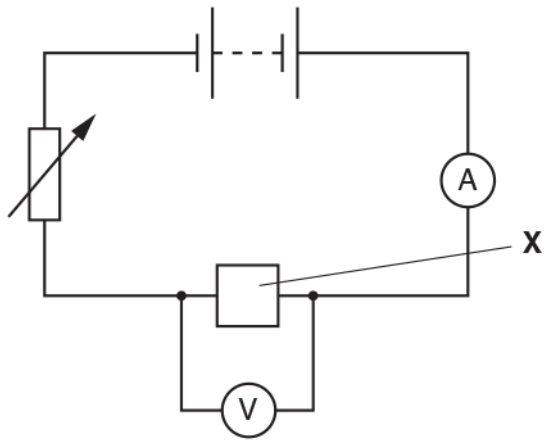
Magnetic Field	Force on wire (N)	Current in wire (A)
A	2.0	0.1
B	2.0	0.2
C	4.0	0.1
D	4.0	0.4

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

Your answer

[1]

13 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]

14

- (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]

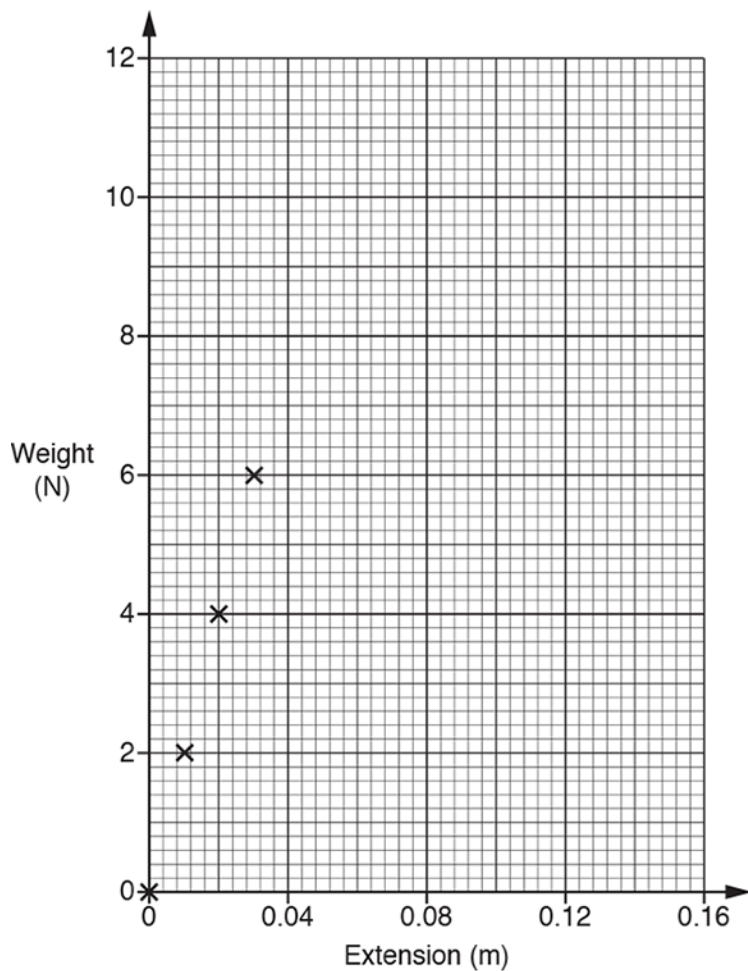
15(a) A student hangs a length of copper wire from the ceiling.

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]

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

Calculate the specific latent heat.

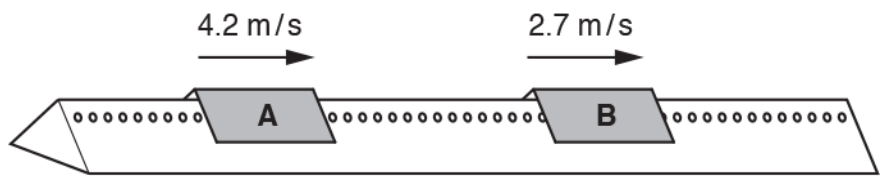
Answer = ... J/kg [3]

17(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]

18 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]

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

The fire has an efficiency of 0.8.

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

Calculate the useful output energy transfer per minute.

- A 600 J
- B 2400 J
- C 36 000 J
- D 144 000 J

Your answer

[1]

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

The water gains 240 000 J of gravitational potential energy.

The gravitational field strength is 10 N/kg.

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

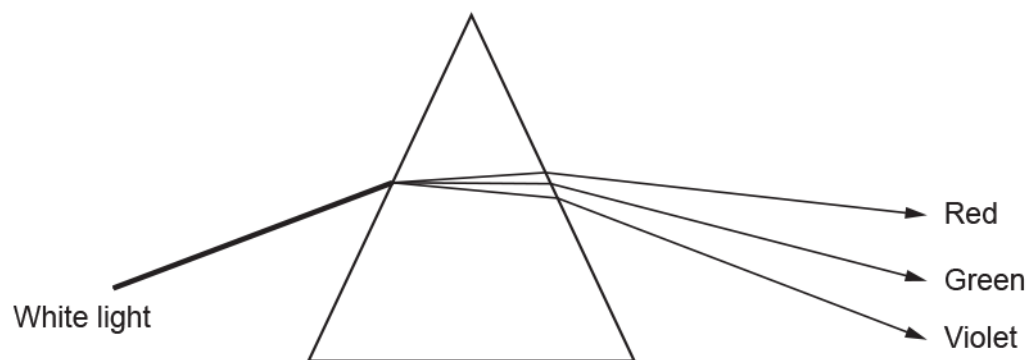
Calculate the height of the water tank.

- A 4.8 m
- B 48 m
- C 240 m
- D 480 m

Your answer

[1]

21 Look at the diagram of white light as it passes through a prism.



A spectrum of colours is seen. It ranges from red to violet.

Why does the **violet** light refract **more** than the red light?

- A Violet light changes frequency more than red light.
- B Violet light has the largest change in speed.
- C Violet light has the smallest change in speed.
- D Violet light increases its speed in the glass prism.

Your answer

[1]

22 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]

() 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]

23 Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 μm				

The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

[2]

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

Answer = ... nm [3]

24(a) A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	22
E	8	5	6
F	32	30	120

Which driver has the **quickest** reaction time?

Driver has the **quickest** reaction time.

Calculate their reaction time.

Answer = ... s [3]

(b) Driver C travels at 32 m/s on the road and then stops. The car has a mass of 1200 kg.

(i) Show that the kinetic energy stored by the car at 32 m/s is 614 000 J.

[3]

(ii) Describe what happens to the kinetic energy of the car as it brakes and stops.

[2]

(iii) The braking distance of the car is 96 m.

Calculate the braking force on the car.

Give your answer to 4 significant figures.

Answer = ----- N [3]

25 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]

26 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

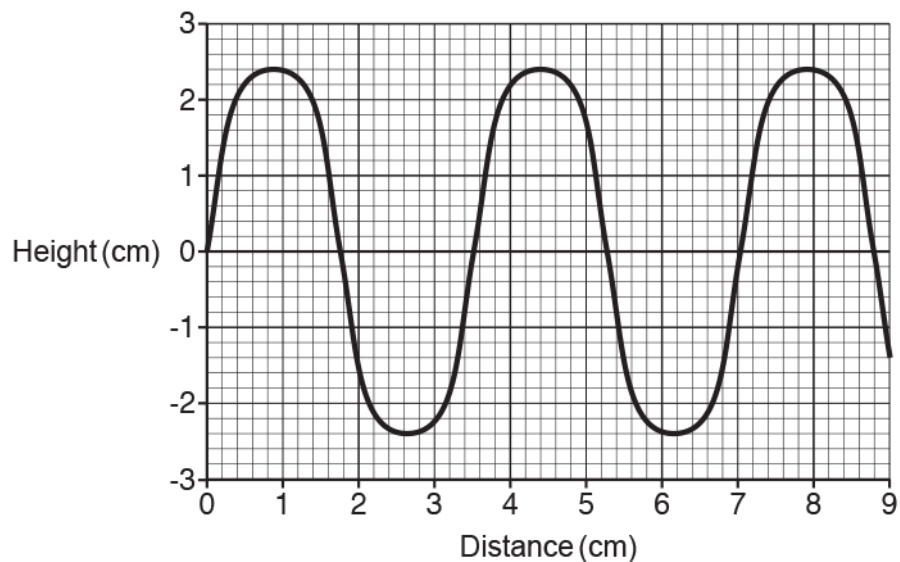
C 1 575 000 J

D 3 150 000 J

Your answer

[1]

27 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]

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

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

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

Answer = ... J [2]

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

..... [1]

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

..... [1]

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

----- [1]

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

----- [1]

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

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

Give your answer to 2 significant figures.

Answer = ----- % [2]

29

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]

30(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/s^2 .

The force on the roller coaster car is 4000 N.

Calculate the **mass** of the roller coaster car.

Answer = ----- kg [2]

31 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]

32 A 2.0 kg object moves at a velocity of 40 m / s.

What is the momentum of the object?

Use the equation: momentum = mass $\times$ velocity

A 20 kg m / s

B 38 kg m / s

C 42 kg m / s

D 80 kg m / s

Your answer

[1]

33 A liquid has a volume of 0.01 m³ and a mass of 12 kg.

What is the density of the liquid?

Use the equation: density = mass $\times$ volume

A 0.12 kg / m³

B 12 kg / m³

C 120 kg / m³

D 1200 kg / m³

Your answer

[1]

34 On the Moon, a 10 kg mass has a weight of 16 N.

What is the gravitational field strength on the Moon?

- A 1.6 N / kg
- B 6.0 N / kg
- C 26 N / kg
- D 160 N / kg

Your answer

[1]

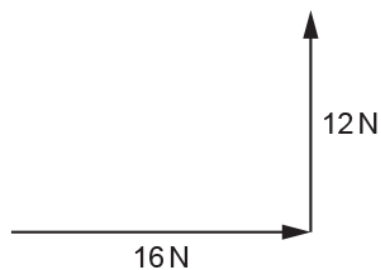
35 Which object has the **most** gravitational potential energy?

- A 1 kg bag on a shelf 1 m above the ground
- B 2 kg bag on a shelf 1 m above the ground
- C 2 kg bag on a shelf 2 m above the ground
- D 1 kg bag on a shelf 2 m above the ground

Your answer

[1]

36 Two forces act at right angles to each other.



What is the magnitude of the resultant force?

A 18 N

B 20 N

C 22 N

D 24 N

Your answer

[1]

37 A spring stretches by 2.0 cm when a force is added.

The spring constant is 60 N / m.

Calculate the energy transferred to the spring when it is stretched.

A 0.012 J

B 0.024 J

C 120 J

D 240 J

Your answer

[1]

38(a) A TV has the label below on it.

OCR TV
Voltage: 230 V
Power: 65 W
Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to 2 significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

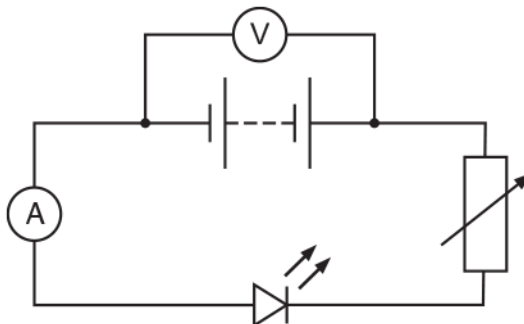
Calculate the energy transferred by the TV.

Energy used = ... J [4]

39(a) A student investigates the electrical characteristics of a light emitting diode (LED).

The student builds a circuit to investigate how the current through an LED and the potential difference across it vary when the LED lights up.

Look at the circuit diagram.



(i) The student has made **two** errors connecting the circuit.

Identify the errors.

1 _____

2 _____

[2]

(ii) What is the purpose of the component  in the circuit?

_____ [1]

(b) The student then connects the circuit correctly. He measures the current through the LED as 0.03 A when the potential difference across it is 3.0 V.

(i) Calculate the resistance of the LED.

Use the equation: potential difference = current $\times$ resistance

Resistance = ... Ω [3]

(ii) Calculate the charge which flows when this LED operates for 2.5 minutes.

Charge = ... C [4]

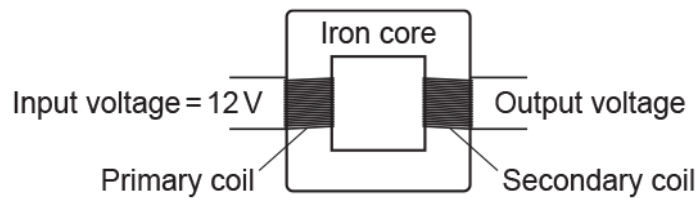
(iii) Calculate the energy transferred when this LED operates for 2.5 minutes.

Use the equation: energy transferred = charge $\times$ potential difference

Energy transferred = ... J [2]

40 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.

Using an input voltage of 12 V the student measures the output voltage.

Look at the results.

Attempt	Number of turns in primary coil	Number of turns in secondary coil	Output voltage (V)
A	100	200	23
B	200	100	6
C	300	600	23
D	600	300	6

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

[6]

41(a) A student investigates how the angle of a ramp affects the final speed of a trolley.

He uses light gates to record the speed of the trolley at the bottom of the ramp.

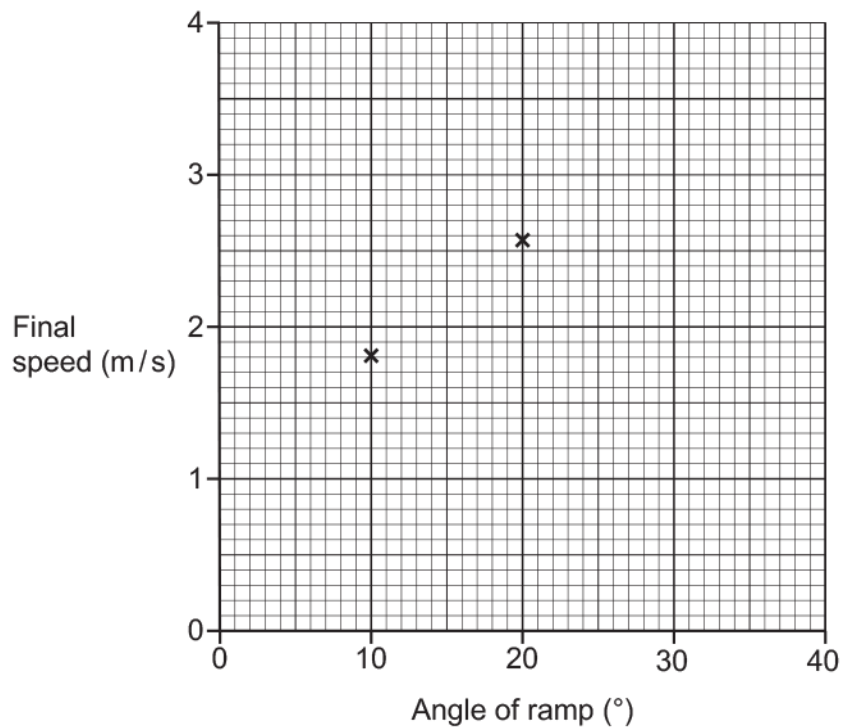
The student releases the trolley from rest at the same point on the ramp each time.

Look at his results.

Angle of ramp (°)	Final speed (m / s)			
	Attempt 1	Attempt 2	Attempt 3	Mean
10	1.81	1.80	1.81	1.81
20	2.58	2.56	2.57	2.57
30	3.1	3.11	3.11	3.11
40	3.52	3.51	3.50	3.51

(i) Plot the results on the graph and draw a line of best fit.

Two results have been plotted for you.



[2]

(ii) Describe the pattern shown by the results.

Use data from the table or graph in your answer.

[3]

(iii) Explain why the final speed changes when the angle of the ramp increases.

In your answer use ideas about energy.

[2]

- (iv) The student made a mistake when recording one of his results.

Identify the mistake **and** explain what he should have done.

[2]

- (v) The student thinks this data shows that his results are **reproducible**.

He is **not** correct.

Explain why.

[2]

(b)

- (i) The mean final velocity for the ramp at a 40° angle is 3.51 m / s . The distance from the top of the ramp to the light gate at the bottom is 1.0 m .

Calculate the acceleration of the trolley when the ramp is at a 40° angle.

Give your answer to decimal places.

Acceleration = ... m / s^2 [5]

- (ii) The trolley has a mass of 2.0 kg .

Calculate the kinetic energy of the trolley at a speed of 3.0 m / s .

Kinetic energy = ... J [3]

42(a) A student investigates four gases.

Look at her data.

Gas	Pressure (Pa)	Volume (m ³)
A	5	0.5
B	10	0.4
C	20	0.2
D	40	0.2

Two readings are for the same mass of the same gas at a constant temperature.

Which two readings are for the **same mass** of the **same gas** at a constant temperature?

Use calculations in your answer.

[3]

(b) Calculate the pressure at the bottom of a 0.5 m tall measuring cylinder filled with a liquid.

Density of the liquid = 1100 kg / m³.

Pressure = ... Pa [3]

43 On Mars the gravitational field strength is 4.0 N / kg .

How much would a 60 kg person weigh on Mars?

Use the equation: $\text{weight} = \text{mass} \times \text{gravitational field strength}$

A 15 N

B 64 N

C 240 N

D 600 N

Your answer

[1]

44 A car travels at 72 km / h .

How fast is this in metres per second (m / s)?

A 1.2 m/s

B 20 m/s

C 120 m/s

D 1200 m/s

Your answer

[1]

45 An object has a volume of 1.5 m^3 and a mass of 3.0 kg .

What is the density of the object?

Use the equation: $\text{density} = \text{mass} \div \text{volume}$

A 0.5 kg/m^3

B 2.0 kg/m^3

C 4.5 kg/m^3

D 6.0 kg/m^3

Your answer

[1]

46(a) The student finds that the current is 20 mA when the potential difference is 4.0 V .

Calculate the **resistance** of the unknown resistor.

Include the **unit** for resistance in your answer.

Use the equation: $\text{resistance} = \text{potential difference} \div \text{current}$.

Resistance = ... Unit = ... [4]

(b) Calculate the **charge** that flows when a current of 2.5 A flows for 30 seconds .

Charge = ... C [3]

47 A 2.0 N weight has a surface area of 0.005 m².

Calculate the **pressure** when it is placed on a surface.

Use the equation: pressure = force normal to a surface ÷ area of that surface

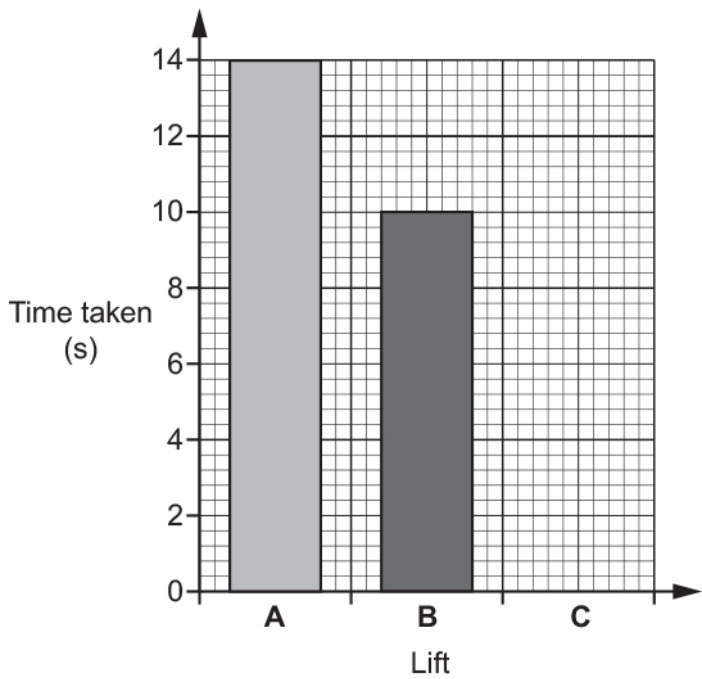
Pressure = ... Pa [2]

48(a) A tall building needs a lift to move people from one floor to another.

The builder has a choice of three different lifts.

Each lift takes a different amount of time to move between the two floors.

Look at a bar chart of the time taken for each lift.



(i) Lift C takes 12 s to move between the two floors.

Draw a bar for lift C on the bar chart.

[1]

(ii) Calculate the **mean** time of the three lift journeys.

Mean = ... s [2]

(iii) Explain which lift uses the most power.

----- [2]

(b)

- (i) One lift uses 50 000 J for a 12 s journey.

Calculate the power of the lift.

Give your answer to 1 decimal place.

Power = ... W [4]

- (ii) When the lift is broken the stairs are used.

Calculate the work done when a 750 N person climbs a distance of 4 m.

Work done = ... J [3]

49 A student investigates the acceleration with which a trolley travels down a ramp.

The trolley starts from rest and reaches a final speed of 2 m / s.

The ramp length is 2.0 m.

Calculate the acceleration of the trolley.

Acceleration = ... m / s² [4]

50(a) A TV has the label below on it.

OCR TV

Voltage: 230 V

Power: 65 W

Frequency: 50 Hz

Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to 2 significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

Calculate the energy transferred by the TV.

Energy used = ... J [4]

51 A boy of mass 70 kg stands on the end of a diving board.

The boy dives vertically into the swimming pool. The water in the pool is 3.2 m below the diving board.

Calculate the velocity of the boy when he enters the water.

Use an equation from the data sheet to help you.

Gravitational field strength on Earth = 10 N / kg.

Velocity = ... m / s [4]

52 Water can be heated using a 12 V heater.

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

The current in the secondary coil is 9.0 A.

Calculate the current in the primary coil.

Use an equation from the data sheet.

Current = ... A [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		16 / 16.0 / 16.00 (2) If answer incomplete or incorrect then 48 – 15.65 – 16.35 or 48 – 32 scores (1)	2	
	b		220 (cm) (2) If answer is incorrect or incomplete then: Evidence on graph showing a line or curve scores (1)	2	Allow 216 → 224 (2) BUT for a reasonable curve extrapolated allow 216 → 230 (2)
	c	i	Time-period is (directly) proportional to the square root of length / AW (1)	1	Eg. x and y are proportional (1) Eg. 'As square root of length increases in equal steps, the time period increases in equal steps' (1) Allow linear relationship through the origin (1) Allow examples showing this relationship using numbers Ignore merely 'positive correlation'
		ii	3.4 (3) But if answer is incorrect or incomplete then: $6.284 \sqrt{\frac{3}{10}}$ or $2 \times 3.142 \times 0.5477$ scores (2) $2 \times 3.142 \sqrt{\frac{3}{10}}$ scores (1)	3	Allow decimal place error: Eg. 3.441 (2) Allow 34.4 (2) (for candidate who has used 300 cm instead of 3 m) Look for correct substitution AND some correct processing Eg. (π or) $22/7$ for 3.142 Look for the correct substitutions Eg. $2 \times \pi \sqrt{\frac{3}{10}}$ scores (1)

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	0.3 or 0.25 or 0.253..... etc. (2) But if answer is incorrect or incomplete then evidence of correct substitution (in symbols or numbers) scores (1)	2	Eg. $1 = 2 \times 3.14 \times \sqrt{\frac{L}{10}}$ Allow π or 22/7 for 3.142
			Total	10	
2			B ✓	1 (AO2.1)	<u>Examiner's Comments</u> This proved to be the easiest question in Section A, with about 85% of all candidates getting it right. The commonest wrong answer was D.
			Total	1	
3			B ✓	1 (AO2.1)	<u>Examiner's Comments</u> This was the hardest multiple-choice question, with one in six candidates getting it right. Most candidates did not convert cm into m.
			Total	1	
4			C ✓	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5			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	4	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
6	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 B the race distance was 200 and did the race in 31s. However student B and C race distance was the same ^{50m} 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 about 6.5 m/s. This shows that the motion of student A is faster 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
7	a	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.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force $\div$ area ✓ = 10 $\div$ 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.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		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	10	
8		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 × 16 ✓ 4 (V) ✓	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 ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ OR P = I²R ✓ P = 0.25² × 16 ✓ P = 1 (W) ✓	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
9			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	
10			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	
11			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	
12			C ✓	1 (AO2.1)	<u>Examiner's Comments</u> About two thirds of candidates gave the correct answer C.
			Total	1	

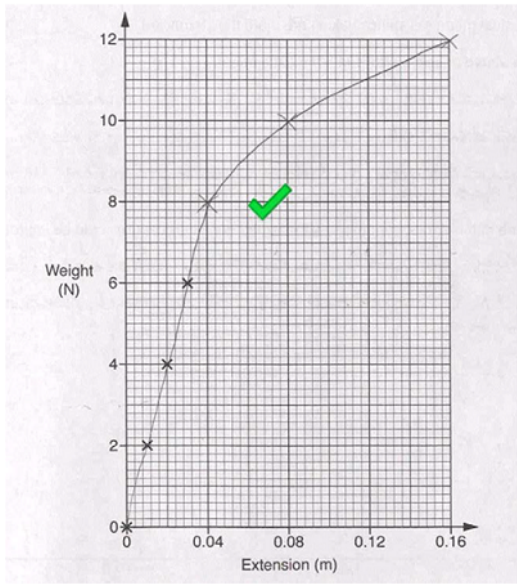
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13		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	

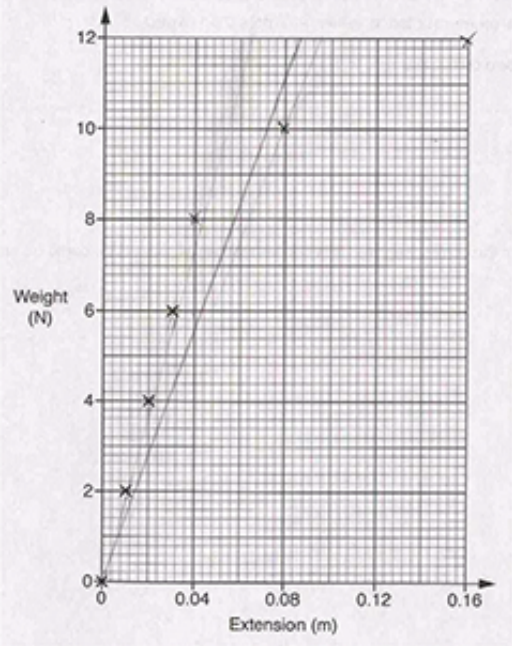
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14		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	

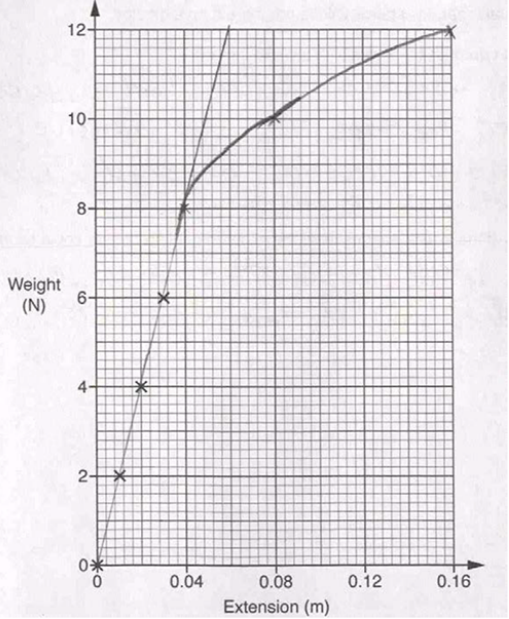
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	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
16			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
17	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
18		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.
			Total	5	
19			D $\checkmark$	1 (AO2.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20			B ✓	1 (AO2.2)	Examiner's Comments  Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below. Exemplar 1 11 A pump lifts 500 kg of water to a water tank at the top of a building. The water gains 240 000 J of gravitational potential energy. The gravitational field strength is 10 N/kg. Use the equation: Potential energy = Mass × Height × Gravitational field strength Calculate the height of the water tank. <u>240000</u> 500 × 10 A 4.8 m B 48 m C 240 m D 480 m Your answer ☒ B [1]
			Total	1	
21			B ✓	1 (AO1.2)	Examiner's Comments Higher ability candidates were able to correctly apply their knowledge of refraction through a prism (option B). Most lower ability candidates chose one of the distractors and were unable to explain why violet light is refracted more than red light.
			Total	1	

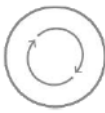
Mark Scheme

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

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
23		i	(Wave speed =) frequency x wavelength ✓ 30 × 10 ⁹ × 0.01 or 30 × 10 ⁹ × 1 × 10 ⁻² ✓	2 (AO1.1) (AO3.2b)	ALLOW correct symbol equation eg (v =) f × λ ALLOW equation in any form ALLOW any frequency and corresponding wavelength from the table substituted into this equation IGNORE units for this marking point only ALLOW 30 000 000 000 × 0.01 or 30 000 000 000 × 1 × 10⁻² ALLOW reverse arguments using speed and wavelength or speed and frequency <u>Examiner's Comments</u>  This question assessed AO1 and AO3 and required candidates to recall and use the equation: <i>wave speed = frequency x wavelength</i> as well as convert 30 GHz into Hertz and 1 cm into metres. Most candidates struggled with the meaning of the prefixes and converting the units. Because many of these candidates did not write down the equation or their workings they could not be credited for any of the compensatory marks available in the mark scheme. A number of candidates used data from the table for radio or infra-red waves. Although they could not gain full marks they were credited with 1 mark for correct use of the equation.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (nm) award 3 marks (Wavelength =) velocity $\div$ frequency ✓ $\frac{3 \times 10^8}{3000 \times 10^{12}}$ or 1×10^{-7} ✓ = 100 (nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW (λ =) $v \div f$ IGNORE $v = f \times \lambda$ and $f = v / \lambda$ or words ALLOW 3×10^8 divided by any frequency from the table IGNORE units for this marking point only Examiner's Comments This question required candidates to convert the prefix Tera into a power of ten, recall and rearrange the equation: <i>wave speed = frequency $\times$ wavelength</i> to calculate the wavelength of ultra-violet, and then convert their answer into nanometres. Only the higher ability candidates gained full credit. The majority of candidates did not score any marks. Those candidates, who did gain credit, were credited with a one mark for correctly rearranged equation or for the correct application of the equation (i.e. 3×10^8 divided by any frequency from the table).  OCR support Candidates would benefit from greater familiarity with the standard metric prefixes (WS1.4d). The Mathematical Skills Handbook provides additional support on the use of prefixes and powers of ten for orders of magnitude: http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
24	a		E ✓ FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.6 (s) award 2 marks 5 ÷ 8 ✓ = 0.6 (s) ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 0.625 or 0.63 (s) <u>Examiner's Comments</u> Most candidates were able to identify that driver E had the quickest reaction time. Only the higher ability candidates were then able to correctly calculate the reaction time. Calculations were sometimes shown and a common error made by candidates when calculating the reaction time was to use (<i>thinking distance + braking distance</i>) ÷ <i>speed</i>.
	b	i	AWARD ALL CANDIDATES 2 MARKS	2 (AO1 × 2.1) (AO1 × 1.2)	<u>Examiner's Comments</u> We have adjusted the mark scheme to allow for a typo within this question.
		ii	KE transferred to thermal energy / heat in brakes / surroundings / AW ✓✓ OR (KE of car) is reduced / transferred ✓ Brakes gain / absorb thermal energy / heat ✓	2 (AO1.1) (AO1.2)	ALLOW surroundings gain thermal energy / heat dissipated to surroundings IGNORE just brakes get hot <u>Examiner's Comments</u> The majority of candidates knew that the kinetic energy store would decrease or be transferred and so were credited with one mark. Fewer candidates gained the second mark as although they referred to heat or thermal energy they did not specify that the energy was transferred to the brakes or surroundings (i.e. into a thermal energy store).
		iii	AWARD ALL CANDIDATES 3 MARKS	3 (AO2 × 2.1) (AO1.2)	
			Total	10	

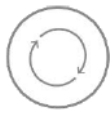
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
25			D ✓	1 (AO 2.1)	<u>Examiner's Comments</u> Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	1	
26			C ✓	1 (AO 2.2)	<u>Examiner's Comments</u> 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
27		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 <u>Examiner's Comments</u> 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.
			Total	4	

Mark Scheme

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

Mark Scheme

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

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29			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.
			Total	3	

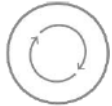
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
30	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 $\times$ 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 $\times$ 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
31		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 <u>Examiner's Comments</u> Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	
32			D ✓	1 (AO2.1)	<u>Examiner's Comments</u> This was a straightforward question to begin section A. Almost all the candidates correctly substituted the numbers into the given equation. Some candidates wrote their working in the space around the question. The advantages of this method are that there is a smaller chance of making a mistake by using the wrong numbers and it is easier to check the answer later.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
33			D ✓	1 (AO2.1)	<u>Examiner's Comments</u> Most candidates correctly substituted the numbers into the given equation.
			Total	1	
34			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> This question was generally answered well. Candidates should be encouraged to consider the units. In the units in each answer is given as N / kg, then 16 N should be divided by 10 kg giving an answer of 1.6 N / kg.
			Total	1	
35			C ✓	1 (AO2.1)	<u>Examiner's Comments</u> The majority of candidates realised that the mass ($\times g$) $\times$ distance above the ground was needed. For this type of question, it is good to calculate the potential energy for each option.
			Total	1	
36			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> This question was generally well answered. Candidates should be encouraged to use the space around the question for their working.
			Total	1	

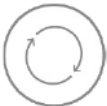
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> This was well answered by higher ability candidates. Often the half or the change of unit (cm to m) was missing. Higher ability candidates wrote the equation from the data sheet, then substituted the numbers into the equation and then carried out the calculation.
			Total	1	

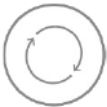
Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
38	a	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28$ (A) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf Examiner's Comments Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.2826 before rounding the answer as 0.28 (two significant figures). A number of candidates wrote their answer exactly from the calculator as 0.28 which was not acceptable for two significant figures. Exemplar 1 17 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the current in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. $\text{Current} = \frac{\text{Power}}{\text{Potential difference}}$ $= \frac{65}{230}$ $= 0.2826\dots$ Current = 0.28 A [4] This candidate has clearly rearranged the equation and then substituted the correct numbers from the data box. It is then clear that the candidate has then calculated the correct answer before rounding it correctly to two significant figures.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					The candidate has perhaps helpfully crossed out the frequency as this is not needed for this part. Candidates need to be careful about crossing out quantities as the crossed out quantities might be needed in later parts. Underlining the quantities needed is probably a better method.  AfL For calculations, candidates should show their working. The following steps are useful: 1 Recall equation or select the appropriate equation from the data sheet (if not given in the question) 2 rearrange equation, if necessary 3 substitute the numbers into the equation 4 calculate the answer 5 consider significant figures or decimal places.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000$ (J) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000$ (J) ✓ <u>Examiner's Comments</u> Candidates did not always know which equation to use. Many recalled correctly the equation relating energy, power and

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					time but did not always remember that the energy needed to be measured in seconds. Higher ability candidates clearly showed their working including the conversion of 30 minutes to 1800 seconds. Some candidates recalled that $E = Q \times V$ and $Q = I \times t$ or $E = I \times t \times V$ and used the answer from 17(a). This was correct physics and thus gained full credit.  AfL When carrying out calculations, candidates should consider units. Normally time is measured in second. Candidates should be aware of exceptions to the normal units, e.g. when energy transferred is measured in kW h, then the power is measured in kilowatt, kW and time in hour h. Similarly, if a speed is measured in measured in km / h, then the distance should be measured in kilometre, km and the time in hour, h.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
39	a	i	LED / cells connected the wrong way around OR ✓ Voltmeter is across the battery/cells OR voltmeter should be across the LED ✓	2 (AO2x3 .2a)	ALLOW diode IGNORE voltmeter in wrong place <u>Examiner's Comments</u> The majority of the candidates gained at least one mark. Vague answers such as "voltmeter is in the wrong place" did not gain credit. Higher ability candidates stated for one of the errors that the LED (or cells) were connected the wrong way around or the LED (or cells) needed to be reversed. For the other error, it was expected that the candidates would indicate that the voltmeter was not measuring the potential difference across just the LED, but across the battery. Candidates gained a mark for this error by suggesting connecting the voltmeter across the LED. Incorrect answers given by many candidates included the ammeter being in the wrong place or the variable resistor being in the wrong place. Often candidates incorrectly suggested that the order of the components mattered.
		ii	Any one from: Control/change/alter the current (in the circuit) ✓ Control/change/alter the potential difference/voltage (across the LED) ✓	1 (AO1.2)	DO NOT ALLOW to vary the resistance <u>Examiner's Comments</u> A large number of candidates answered this question by stating that the component was a variable resistor or to vary the resistance of the circuit. Few candidates answered the question in term of the purpose of the variable resistor was to vary the potential difference across the LED or vary the current through the LED (by varying the resistance in the circuit).

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Ω) award 3 marks Resistance = potential difference $\div$ current / $R = V \div I$ ✓ $R = 3.0 \div 0.03$ ✓ $R = 100 (\Omega)$ ✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> The majority of the candidates were able to rearrange the given equation and substitute into the rearranged equation the correct values to give an answer of 100 Ω. A very small minority of candidates used 0.3 A rather than 0.03 A. Candidates often underline the quantities in the question, which was good practice.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.5 (C) award 4 marks Charge flow = current $\times$ time / $Q = I \times t$ ✓ $t = 2.5$ minutes = 150 seconds ✓ $Q = 0.03 \times 150$ ✓ $Q = 4.5$ (C) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	ALLOW 3 marks for an answer of 0.075 (C) (time not converted to seconds) ✓✓✓ <u>Examiner's Comments</u> In this question, higher ability candidates who did not obtain the correct answer, but showed their working, could still gain marks from their working. In this case, the equation for charge flow needed to be recalled and the time of 2.5 minutes needs to be changed to 150 seconds, before the answer could be calculated.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 13.5 (J) award 2 marks $E = 4.5 \times 3.0$ ✓ $E = 13.5$ (J) ✓	2 (AO2.1) (AO2.1)	ECF from (ii) ALLOW 14(J) <u>Examiner's Comments</u> Most candidates were able to multiply their answer to (ii) by 3.0 to gain the correct answer.
			Total	12	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
40	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

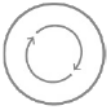
Mark Scheme

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

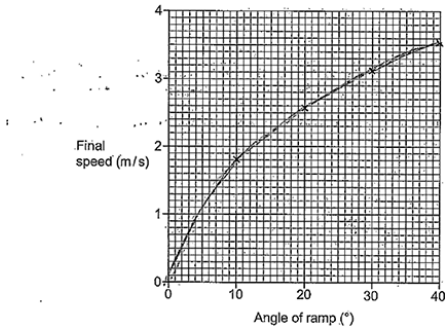
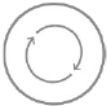
Mark Scheme

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 inside the iron core. The secondary coil is coiled 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 the formula. doesn't support the how a transformer works as the output voltage is expected to be 240V, not 220V. [6] 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.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
41	a	i	Both points correctly plotted ✓ Smooth curve correctly drawn ✓	2 (AO1.2)	ALLOW within ½ small square for plotting DO NOT ALLOW straight lines between data points IGNORE any line drawn for $<10^\circ$ <u>Examiner's Comments</u> Candidates needed to plot the last two data points before drawing the best fit line. Many candidates incorrectly drew a straight line through plots that appeared to lie on a curved trend. Other candidates did not draw smooth curves, or had many lines. Exemplar 5  This candidate has clearly indicated the correct positions of the two missing plots using two small crosses. The smooth line was not considered good enough in that there appeared to be more than one line in several places. This candidate has correctly assumed that the graph starts from the origin.  AfL Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. It may help candidates to draw smooth curves by rotating the paper so that the

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					curve can be drawn naturally with the arc of the candidates' arm. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Increase in angle of ramp increases speed (at bottom ramp) OR A✓ Increase is not linear/doubling angle does not double final speed / AW ✓ Reference to quantitative data for two calculations, for example, increase from 10° to 20° the speed increases by 0.76 whilst 20° to 30° the speed increases by 0.54 ✓	3 (AO3.1a) (AO3.1a) (AO3.1b)	IGNORE correlation ALLOW Not directly proportional / Not constant increase NOTE comparison of two increases required NOTE Speed increase from 0° to 10° is 1.81 and speed increase from 30° to 40° is 0.40 <u>Examiner's Comments</u> Most candidates correctly stated that the as the angle of the ramp increased the speed increased. It was essential that candidates included a comparison between the angle of the ramp and the speed. The next two marks were more challenging and required candidates to state that the angle of the ramp and the speed were not directly proportional or linear since there was not a constant increase in speed for the same increase in angle. Candidates were expected to demonstrate this by carrying out two calculations using data from the table or graph. AfL Understand how to test from a graph whether two quantities are directly proportional. 1 Take the quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2 See whether there is a straight line through the origin.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(Increase in angle) increases potential energy of the trolley/more work is done raising trolley to that point on the ramp ✓ This increases the / more kinetic energy at the bottom of the ramp ✓	2 (AO1.1 x2)	ALLOW more PE is transferred to KE <u>Examiner's Comments</u> Most candidates found this question challenging to gain two marks due to some vague answers relating to the transfer energy from the PE store to the KE store without specifically referring to the greater energy in the PE store being transferred so that there more energy in the KE store.
		iv	Attempt 1 at 30° (is only recorded to 1 decimal place)/ 3.1 ✓ Student should record data to a consistent number of decimal places or 2 dp / the reading should be recorded as 3.10 / AW ✓	2 (AO3.3a) (AO3.3b)	ALLOW only recorded to 2 significant figures ALLOW should be recorded to 3 significant figures NOT same accuracy <u>Examiner's Comments</u> Many candidates correctly identified that the first attempt (3.1) at an angle of 30° was only recorded to one decimal place. Most candidates then suggested that that the raw data should have been recorded to the same number of decimal places and the reading should have been recorded as 3.10. Some candidates referred to significant figures, which was allowed this year. Candidates need to understand that raw data should be recorded to the same number of decimal places while calculated data is recorded to a number of significant figures which is dependent on the number of significant figures in the raw data.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		v	Any two from: Reproducible means that the results can be reproduced by someone else ✓ Only one student has collected this data ✓ The experiment is repeatable (as the repeated readings are close together) ✓	2 (AO2.2 x2)	NOT experiment can be repeated <u>Examiner's Comments</u> Most candidates discussed apparatus details such as not indicating what sort of surface was used, etc. Few candidates realised that reproducible results would need to be reproduced by someone else. A few candidates did state that the experiment is repeatable since the repeated reading are close to each other. AfL Understand the terms used in the language of measurement. See the Glossary of terms on the OCR website at: https://www.ocr.org.uk/Images/467774-glossary-of-terms.doc
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.16 (m/s²) award 5 marks $v^2 - u^2 = 2as$ (no mark – on formula sheet) $u = 0$ ✓ $a = v^2 \div 2s$ ✓ $a = 3.51^2 \div (2 \times 1.0)$ ✓ $a = 6.16005$ (m/s²) ✓ $a = 6.16$ (m/s²) (2 decimal places) ✓	5 (AO2.1) (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE must be rearranged ALLOW Any number which rounds to 6.16 ALLOW one mark for any calculated answer to 2dp <u>Examiner's Comments</u> About half the candidates gained full marks for this question. It was expected that candidates would

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					select an appropriate equation from the data sheet, rearrange the equation and substitute in the numbers from the question before calculating the answer. It was expected that the initial speed of zero would be shown in any calculation. Many candidates who did not gain full marks attempted to gain the answer by using the definition of acceleration and the equation linking average speed with distance and time without realising the importance of the word "average". Candidates using this method often arrived with an incorrect answer of 12.32 m/s^2. Exemplar 6 $(final\ velocity)^2 - (initial\ velocity)^2 = 2 \times acceleration \times distance$ $acceleration = \frac{(final\ velocity)^2 - (initial\ velocity)^2}{2 \times distance}$ $= \frac{(3.5)^2 - (0)^2}{2} = \frac{(3.5)^2}{2} = 6.16005$ Acceleration = <u>6.16</u> m/s² [5] This candidate has correctly selected the equation from data sheet. The candidate has then rearranged the equation before substituting in the values from the question. Helpfully the candidate has indicated that the initial velocity was zero. The candidate then correctly calculates the answer as 6.16005 before correctly rounding the answer to two decimal places.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 9 (J) award 3 marks kinetic energy (J) = $0.5 \times \text{mass (kg)} \times (\text{speed (m/s)})^2 /$ KE = $\frac{1}{2} mv^2$ / KE = $0.5mv^2$ ✓ KE = $0.5 \times 2.0 \times 3.0^2$ ✓ KE = 9 (J) ✓	3 (AO1.2) (AO2.1) (AO2.1)	Examiner's Comments Candidates who were able to recall the equation for kinetic energy scored well on this question. Candidates should be encouraged to show their working.
			Total	19	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
42	a	Pressure is inversely proportional to volume OR $pV = \text{constant}$ for a particular gas OR for any of the gases calculation of $p \times V$ ✓ For gas B: $10 \times 0.4 = 4$ <u>and</u> for gas C: $20 \times 0.2 = 4$ OR Pressure of C is double the pressure of B <u>and</u> volume of C is half the volume of B ✓ B and C ✓	3 (AO3.2b) (AO3.1a) (AO3.2b)	NOTE could be written next to table <u>Examiner's Comments</u> This question required candidates to use the data in the table which was generally well answered by all candidates. Higher ability candidates clearly stated that pressure is inversely proportional to volume and then went on to state that pressure $\times$ volume = constant. Most candidates then calculated for each gas pressure $\times$ volume before stating that B and C were the same. A few candidates demonstrated that doubling the pressure halved the volume and gained full credit with the appropriate conclusion.
	b	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5500 (Pa) award 3 marks pressure due to a column of liquid (Pa) = height of column (m) $\times$ density of liquid (kg/m³) $\times$ g (N/kg) / $P = h\rho g$ (no mark – on formula sheet) $g = 10$ (N/kg) ✓ $P = 0.5 \times 1100 \times 10$ ✓ $P = 5500$ (Pa) ✓	3 (AO1.1) (AO2.1) (AO2.1)	ALLOW three marks for 5390 Pa if $g=9.8$ N/kg or 5395.5 Pa if $g=9.81$ N/kg is used ALLOW 9.8(1) N/kg <u>Examiner's Comments</u> Most of the candidates correctly selected an equation from the data sheet and used an appropriate value for g. Candidates who did not gain credit for this question, tended to just multiply 0.5 by 1100. By understanding that the unit of pressure is Pa or N / m², candidates should be able to reason that $m \times kg / m^3$ is not valid.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	6	
43			C ✓	1 (AO2.1)	
			Total	1	
44			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> This involves two different unit conversions, km to m and h to s. Many successful candidates used the space to set out step-by-step intermediate calculations..
			Total	1	
45			B ✓	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
46	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 Ω award 4 marks Unit conversion 20(mA) = 0.02(A)/20x10⁻³ (A) ✓ $R = 4.0 \div 0.02$ ✓ $R = 200$ ✓ Ω ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	If final unit is kΩ or V/mA, this unit conversion is not needed so mp1 is subsumed into mp2 ECF incorrect or absent conversion of mA to A e.g. a bald answer of 0.2 gains mp2 & mp3 unless the unit is kΩ or V/mA, when all 4 marks are awarded. Mark unit independently ALLOW ohm(s) or V/A or V/mA if consistent with working <u>Examiner's Comments</u> In this question the unit mark was free-standing and so any valid unit combination was allowed. Both 0.20 kΩ and 0.2 mA/V are examples of responses which gained 4/4. Because of the application of error-carried-forward, candidates losing the first mark by not converting mA to A did not lose subsequent marks, so for example 0.2 Ω with suitable workings could gain three of the four marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 75 (C) award 3 marks Charge flow = current × time / $Q = It$ ✓ $Q = 2.5 \times 30$ ✓ $Q = 75$ (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	Mp1 can be assumed if correct substitution follows No ECF from incorrect equation <u>Examiner's Comments</u> Although the concept of electrical charge is difficult for many GCSE candidates, and they were required to recall the equation the majority of candidates were credited with full marks here.
			Total	7	
47			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 400 (Pa) award 2 marks $P = 2 \div 0.005$ ✓ $P = 400$ (Pa) ✓	2 (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Relatively few candidates had problems with dividing by 0.005.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
48	a	i	Bar C drawn to the correct height of 12s ✓	1 (AO1.2)	<u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (s) award 2 marks $14 + 10 + 12 = 36 / (14 + 10 + 12)/3$ without the 36 ✓ $36 \div 3 = 12$ (s) ✓	2 (AO3.1a) (AO1.2)	ECF from (a)(i) ECF from mp1 above <u>Examiner's Comments</u> Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		iii	Lift B ✓ Takes the least time (power is work done ÷ time taken)/AW ✓	2 (AO3.1b) (AO1.2)	If A chosen and correct explanation (for B) given, award mp2 but not mp1 <u>Examiner's Comments</u> Many candidates identified lift B uses the most power correctly but did not provide an explanation of why it use the most power for the second mark. Some candidates clearly thought the highest bar in the bar chart indicated a greater height reached by the lift and so chose lift A.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4166.7 (W) award 4 marks $P = E \div t$ / power = work done $\div$ time taken ✓ $P = 50000 \div 12$ ✓ $P = 4166.666667$ (W) ✓ $P = 4166.7$ (W) (1dp)✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	ALLOW energy (transferred) $\div$ time taken ALLOW 4166.7 for 2 marks if more dp not given ECF own calculated power to 1 dp <u>Examiner's Comments</u> Part (i): required candidates to round their answer to one decimal place. Many candidates did the calculation well and gained 4/4, or 3/4 with incorrect rounding. Any calculation error in finding the power of the lift could still earn the candidate the last mark if their result was rounded correctly. Part (ii) was done correctly by the majority of candidates. The stem of the question contained some data that they did not need to complete the calculation, which made this a more challenging task than it may appear to be.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3000 (J) award 3 marks ✓ Work done = force $\times$ distance ✓ $W = 750 \times 4$ ✓ $W = 3000$ (J) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
49			EITHER $v^2 - u^2 = 2as$ (no mark – on formula sheet) $u = 0$ ✓ $a = v^2 \div 2s$ ✓ $a = 2^2 \div (2 \times 2.0)$ ✓ $a = 1.0/1$ (m/s²) ✓ OR mean $v = \frac{1}{2} (0 + 2 \text{ m/s}) = 1 \text{ m/s}$ ✓ $t = s/\text{mean } v = 2 \text{ m} / 1 \text{ m/s} = 2 \text{ s}$ ✓ $a = \Delta v/t$ ✓ $= (2 \text{ m/s} - 0)/2 \text{ s} = 1 \text{ (m/s}^2\text{)} \checkmark$	4 (AO2.1) (AO2.1) (AO2.1) (AO2.1)	If no working shown and answer = 1 (m/s²), award all 4 marks. If wrong physics used, then award marks as appropriate for either approach. <u>Examiner's Comments</u> There were different possible approaches to the calculation: use of $v^2 = u^2 + 2as$ or finding the mean speed and hence t and using $a = (v-u)/t$. Both were seen. Many candidates just randomly multiplied or divided the numbers given, and two of these operations gave a response of 1 m/s². Where candidates used incorrect physics in their response (e.g. acceleration = speed/distance = 2/2 = 1) then they only gained marks for those parts of their workings that were appropriate. For fairness candidates who only wrote '1' on the answer line with no workings shown were given the benefit of the doubt and awarded all 4 marks.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
50	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation $\text{current} = \text{power} \div \text{potential difference}$ / $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28$ (A) ✓	4 (A1.2) (A2.1) (A2.1) (A1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf <u>Examiner's Comments</u> In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures. Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is $65/4.5 = 14.4444$ which (expressed to 2 s.f.) is 14, so earned second mark was given. Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 9 23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the current in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. $\frac{65}{230} = 0.28$ $\frac{230}{50} = 4.6$ $\frac{65}{4.6} = 14$ $\text{Current} = 14 \text{ A [4]}$
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000 \text{ (J)}$ ✓	4 (A1.2) (A1.2) (A2.1) (A2.1)	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000 \text{ (J)}$ ✓ <u>Examiner's Comments</u> This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
51			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (m/s) award 4 marks $u = 0$ or $v^2 = (u^2 +) 2as$ ✓ $v^2 = 2 \times 10 \times 3.2$ or $v = \sqrt{(2 \times 10 \times 3.2)}$ ✓ $v^2 = 64$ ✓ $v = 8$ (m/s) ✓ OR alternative method: $mgh = \frac{1}{2} mv^2$ ✓ $(70 \times) 10 \times 3.2 = \frac{1}{2} (x 70) \times v^2$ ✓ $64 = v^2$ ✓ $v = 8$ (m/s) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO2.1)	$v^2 - u^2 = 2as$ does not score a mark
			Total	4	
52			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.9 (A) award 2 marks (Rearrangement: $I_p =) I_s \times V_s / V_p$ ✓ OR $(I_p =) 12 \times 9.0 / 120$ ✓ $(I_p =) 0.9$ (A) ✓	2 (AO1.2) (AO2.1)	
			Total	2	