

FOR OFFICIAL USE

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Total Marks

3220/402

NATIONAL
QUALIFICATIONS
2007

WEDNESDAY, 16 MAY
10.50 AM – 12.35 PM

PHYSICS
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

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Scottish candidate number

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Number of seat

Reference may be made to the Physics Data Booklet.

- All questions should be answered.
- The questions may be answered in any order but all answers must be written clearly and legibly in this book.
- Write your answer where indicated by the question or in the space provided after the question.
- If you change your mind about your answer you may score it out and rewrite it in the space provided at the end of the answer book.
- Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.
- Any necessary data will be found in the **data sheet** on page two.
- Care should be taken to give an appropriate number of significant figures in the final answers to questions.



DATA SHEET

Speed of light in materials

<i>Material</i>	<i>Speed in m/s</i>
Air	3.0×10^8
Carbon dioxide	3.0×10^8
Diamond	1.2×10^8
Glass	2.0×10^8
Glycerol	2.1×10^8
Water	2.3×10^8

Speed of sound in materials

<i>Material</i>	<i>Speed in m/s</i>
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Gravitational field strengths

	<i>Gravitational field strength on the surface in N/kg</i>
Earth	10
Jupiter	26
Mars	4
Mercury	4
Moon	1.6
Neptune	12
Saturn	11
Sun	270
Venus	9

Specific heat capacity of materials

<i>Material</i>	<i>Specific heat capacity in J/kg °C</i>
Alcohol	2350
Aluminium	902
Copper	386
Diamond	530
Glass	500
Glycerol	2400
Ice	2100
Lead	128
Water	4180

Specific latent heat of fusion of materials

<i>Material</i>	<i>Specific latent heat of fusion in J/kg</i>
Alcohol	0.99×10^5
Aluminium	3.95×10^5
Carbon dioxide	1.80×10^5
Copper	2.05×10^5
Glycerol	1.81×10^5
Lead	0.25×10^5
Water	3.34×10^5

Melting and boiling points of materials

<i>Material</i>	<i>Melting point in °C</i>	<i>Boiling point in °C</i>
Alcohol	-98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Turpentine	-10	156

Specific latent heat of vaporisation of materials

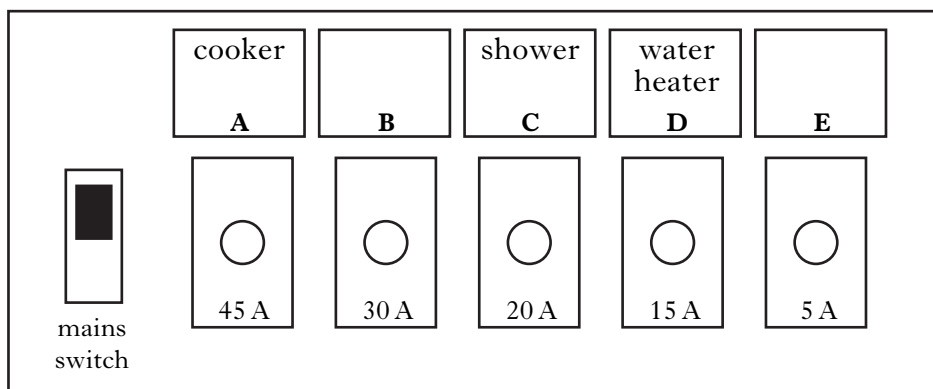
<i>Material</i>	<i>Specific latent heat of vaporisation in J/kg</i>
Alcohol	11.2×10^5
Carbon dioxide	3.77×10^5
Glycerol	8.30×10^5
Turpentine	2.90×10^5
Water	22.6×10^5

SI Prefixes and Multiplication Factors

<i>Prefix</i>	<i>Symbol</i>	<i>Factor</i>
giga	G	1 000 000 000 = 10^9
mega	M	1 000 000 = 10^6
kilo	k	1000 = 10^3
milli	m	0.001 = 10^{-3}
micro	μ	0.000 001 = 10^{-6}
nano	n	0.000 000 001 = 10^{-9}

Marks

4. The consumer unit in a house contains a mains switch and circuit breakers for different circuits.



- (a) (i) What is the purpose of the mains switch?

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- (ii) Two of the circuits have not been labelled.

Which circuit is: the ring circuit?

the lighting circuit? 1

- (iii) The current ratings for the ring circuit and the lighting circuit are different.

State another difference between the ring circuit and the lighting circuit.

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4. (continued)

- (b) (i) A 25 W lamp is designed to be used with mains voltage.
Calculate the resistance of the lamp.

Space for working and answer

3

- (ii) Four of these lamps are connected in parallel.
Calculate the **total** resistance of the lamps.

Space for working and answer

2

[Turn over

Marks

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3	
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2	
1	
1	

5. Two groups of pupils are investigating the electrical properties of a lamp.

(a) Group 1 is given the following equipment:

ammeter; voltmeter; 12 V d.c. supply; lamp; connecting leads.

Complete the circuit diagram to show how this equipment is used to measure the current through, and the voltage across, the lamp.



(b) Group 2 uses the same lamp and is only given the following equipment:

lamp; ohmmeter; connecting leads.

What property of the lamp is measured by the ohmmeter?

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(c) The results of both groups are combined and recorded in the table below.

I(A)	V(V)	R(Ω)	IV	I ² R
2	12	6		

(i) Use these results to complete the last two columns of the table.

Space for working

(ii) What quantity is represented by the last two columns of the table?

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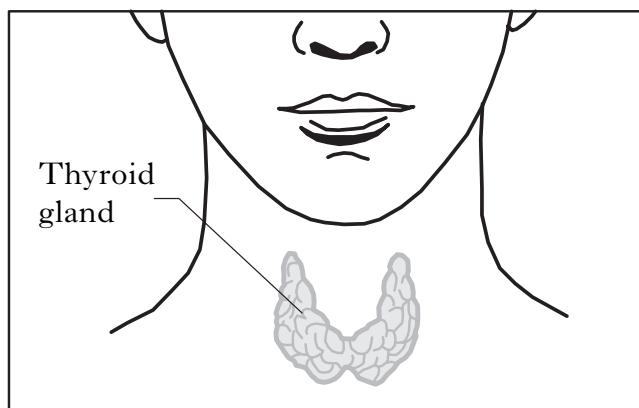
(iii) What is the unit for this quantity?

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K&U	PS
2	
1	
1	
1	

6. The thyroid gland, located in the neck, is essential for maintaining good health.



- (a) (i) A radioactive source, which is a gamma radiation emitter, is used as a radioactive tracer for the diagnosis of thyroid gland disorders.

A small quantity of this tracer, with an activity of 20 MBq, is injected into a patient's body. After 52 hours, the activity of the tracer is measured at 1.25 MBq.

Calculate the half life of the tracer.

Space for working and answer

- (ii) Another radioactive source is used to **treat** cancer of the thyroid gland. This source emits only beta radiation.

Why is this source unsuitable as a **tracer**?

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- (iii) The equivalent dose is much higher for the beta emitter than for the gamma emitter.

Why is this higher dose necessary?

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- (b) What are the units of equivalent dose?

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7. A newborn baby is given a hearing test. A small device, containing a loudspeaker and a microphone, is placed in the baby's ear.



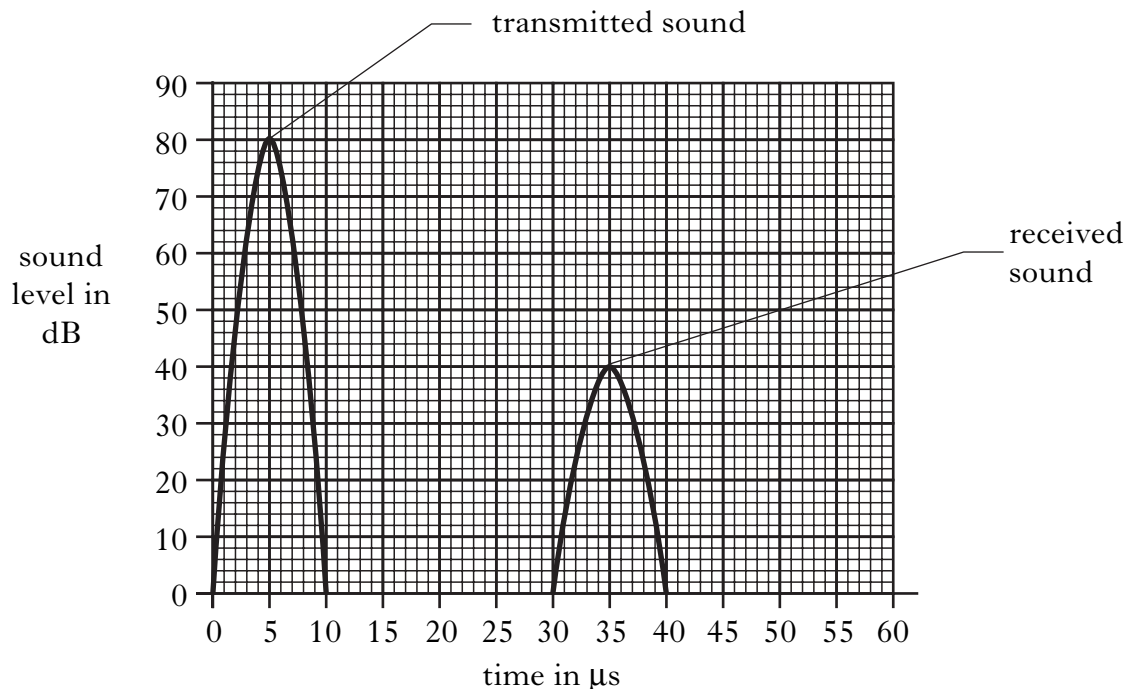
- (a) A pulse of audible sound lasting $10\mu\text{s}$ is transmitted through the loudspeaker. The sound is played at a level of 80 dB.
- (i) Give a reason why this pulse of sound does not cause damage to the baby's hearing.

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1

7. (a) (continued)

- (ii) The transmitted pulse of sound makes the inner ear vibrate to produce a new sound, which is received by the microphone.
Signals from the transmitted and received sounds are viewed on an oscilloscope screen, as shown below.



The average speed of sound inside the ear is 1500 m/s.

Calculate the distance between the device and the inner ear.

Space for working and answer

- (iii) Suggest a frequency that could be used for the hearing test.

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- (b) An ultrasound scan can be used to produce an image of an unborn baby. Explain how the image of an unborn baby is formed by ultrasound.

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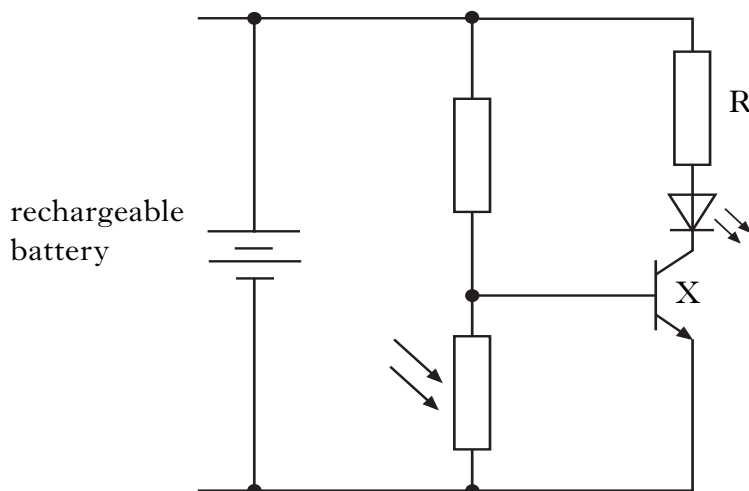
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Marks	K&U	PS
3		
1		
2		

8. (continued)

(b) The LED is switched on using the following circuit.



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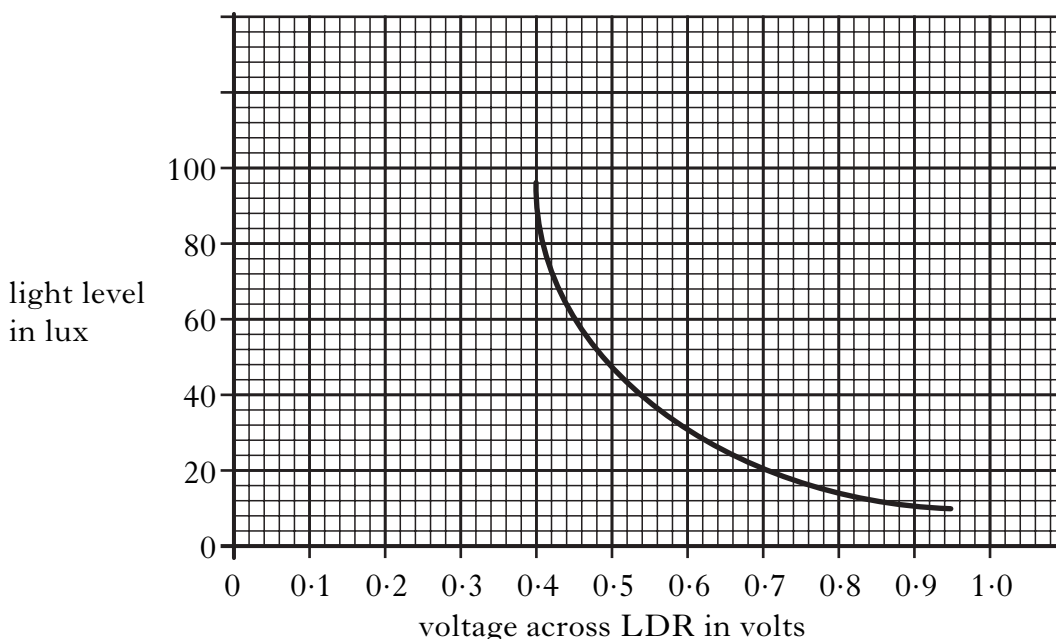
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1	
1	
1	

(i) Name component X.

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The graph below shows the voltage across the LDR in this circuit for different light levels.

Light level is measured in lux.



(ii) For the LED to be lit, the voltage across the LDR must be at least 0.7 V.

What is the maximum light level for the LED to be lit?

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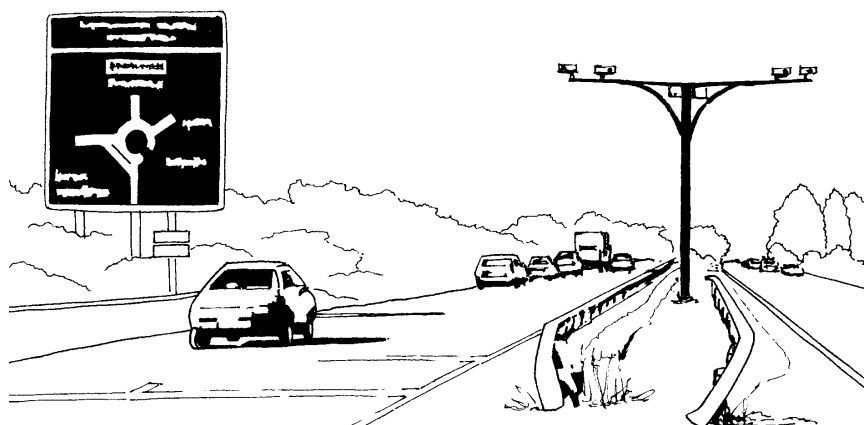
(iii) Explain the purpose of resistor R.

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Marks

K&U	PS
3	
2	

10. Cameras placed at 5 km intervals along a stretch of road are used to record the average speed of a car.



The car is travelling on a road which has a speed limit of 100 km/h. The car travels a distance of 5 km in 2.5 minutes.

- (a) Does the average speed of the car stay within the speed limit?

You must justify your answer with a calculation.

Space for working and answer

3

- (b) At one point in the journey, the car speedometer records 90 km/h.

Explain why the average speed for the entire journey is not always the same as the speed recorded on the car speedometer.

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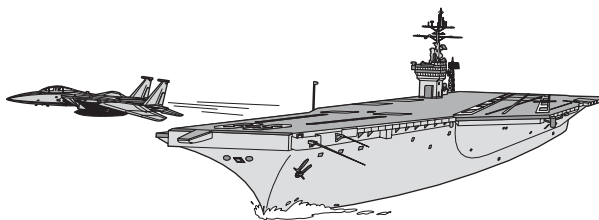
2

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Marks

K&U	PS
2	
2	
1	

11. An aeroplane on an aircraft carrier must reach a minimum speed of 70 m/s to safely take off. The mass of the aeroplane is 28 000 kg.



- (a) The aeroplane accelerates from rest to its minimum take off speed in 2 s.
(i) Calculate the acceleration of the aeroplane.

Space for working and answer

- (ii) Calculate the force required to produce this acceleration.

Space for working and answer

- (iii) The aeroplane's engines provide a total thrust of 240 kN. An additional force is supplied by a catapult to produce the acceleration required.

Calculate the force supplied by the catapult.

Space for working and answer

Marks

K&U	PS
2	
2	

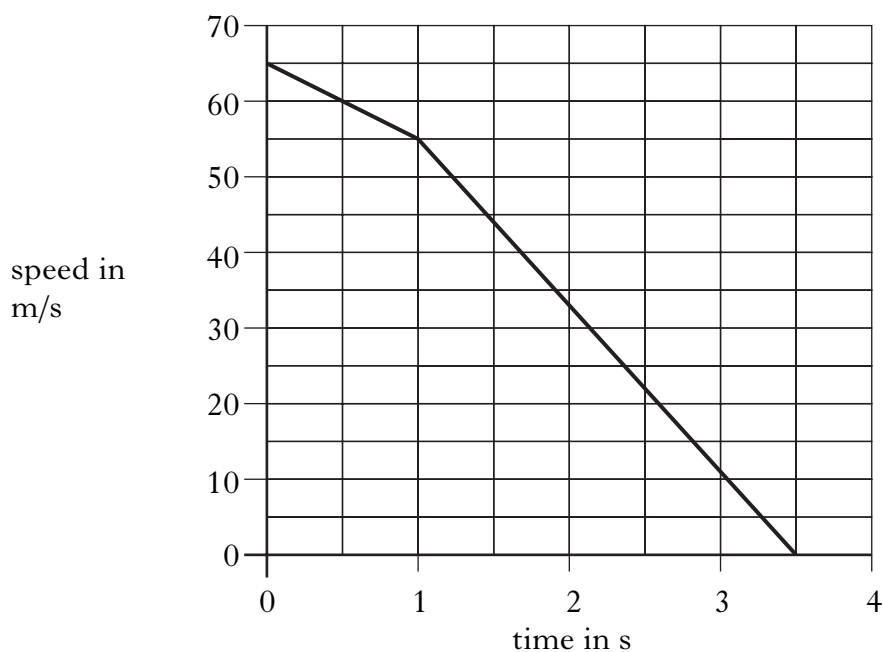
11. (continued)

(b) Later, the same aeroplane travelling at a speed of 65 m/s, touches down on the carrier.

(i) Calculate the kinetic energy of the aeroplane at this speed.

Space for working and answer

(ii) The graph shows the motion of the aeroplane from the point when it touches down on the carrier until it stops.



Calculate the distance travelled by the aeroplane on the carrier.

Space for working and answer

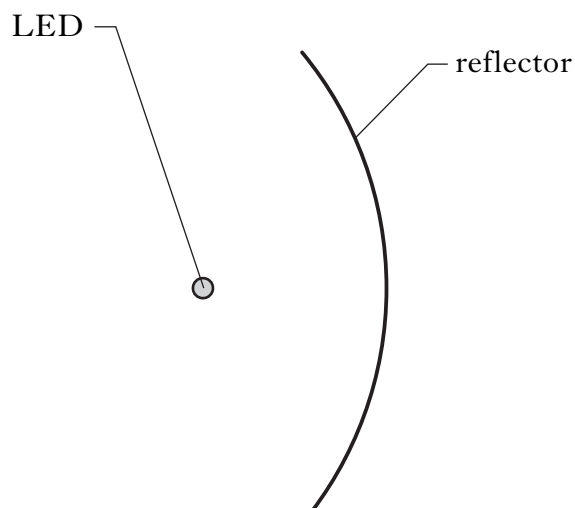
Marks

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2	

12. (continued)

(c) The torch produces a beam of light.

The diagram shows the LED positioned at the focus of the torch reflector.



Complete the diagram by drawing light rays to show how the beam of light is produced.

2

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Marks

K&U	PS

13. An electric kettle is used to heat 0.4 kg of water.

(a) The initial temperature of the water is 15 °C.

Calculate how much heat energy is required to bring this water to its boiling point of 100 °C.

Space for working and answer

3

(b) The automatic switch on the kettle is not working. The kettle is switched off 5 minutes after it had been switched on.

The power rating of the kettle is 2000 W.

(i) Calculate how much electrical energy is converted into heat energy in this time.

Space for working and answer

2

(ii) Calculate the mass of water changed into steam in this time.

Space for working and answer

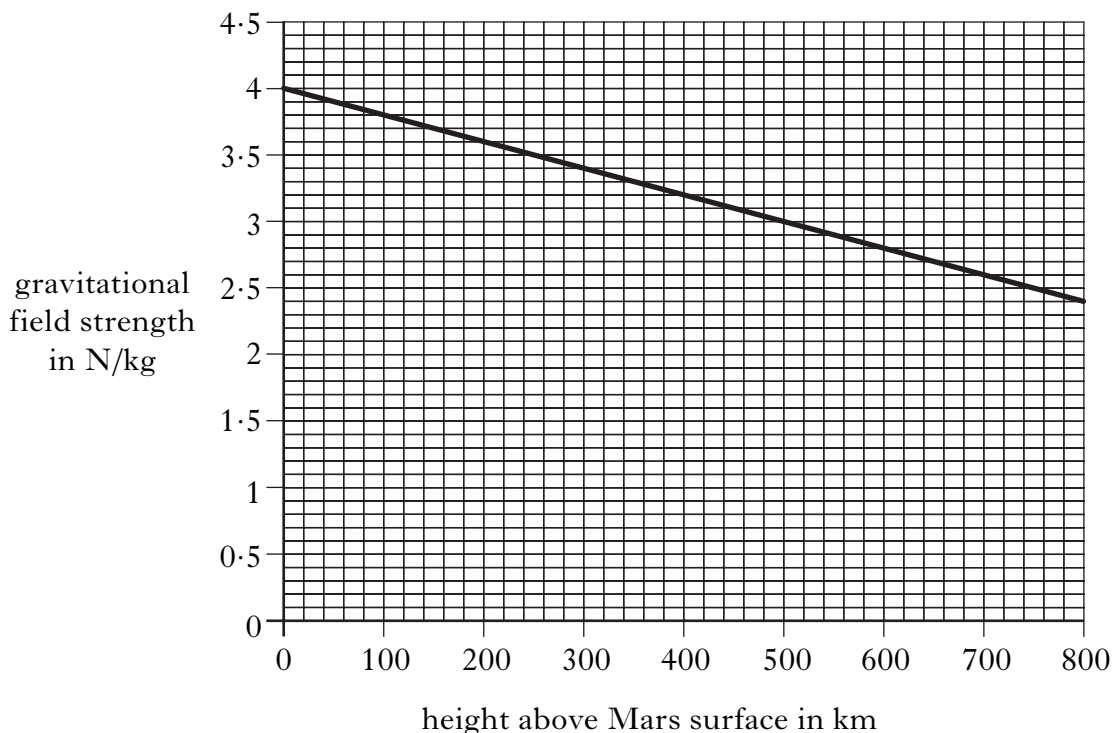
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15. In June 2005, a space vehicle called Mars Lander was sent to the planet Mars.

(a) The graph shows the gravitational field strength at different heights above the surface of Mars.



(i) The Mars Lander orbited Mars at a height of 200 km above the planet's surface.

What is the value of the gravitational field strength at this height?

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(ii) The Mars Lander, of mass 530 kg, then landed.

Calculate the weight of the Mars Lander on the surface.

Space for working and answer

3

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YOU MAY USE THE SPACE ON THIS PAGE TO REWRITE ANY ANSWER YOU HAVE DECIDED TO CHANGE IN THE MAIN PART OF THE ANSWER BOOKLET. TAKE CARE TO WRITE IN CAREFULLY THE APPROPRIATE QUESTION NUMBER.

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