Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3420UA0-1

S18-3420UA0-1

PHYSICS – Unit 1:
Electricity, Energy and Waves

HIGHER TIER

FRIDAY, 15 JUNE 2018 – MORNING

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**11**	
3.	**8**	
4.	**9**	
5.	**9**	
6.	**13**	
7.	**15**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this paper you will require a calculator, a ruler and a drawing compass..

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet. If you run out of space use the additional page at the back of the booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **6*(a)***.

Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
total resistance in a parallel circuit	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
power = current^2 × resistance	$P = I^2R$
% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}}$ × 100	
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
	T / K = θ / °C + 273
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

SI multipliers

Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

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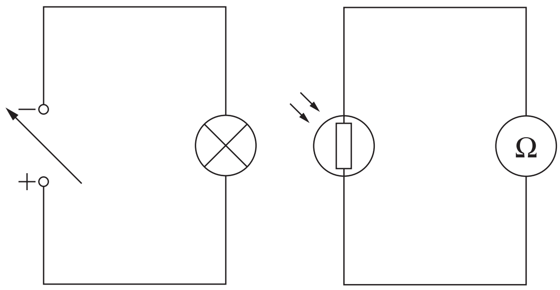
Answer **all** *questions.*

1. The following circuits are set up to investigate a light dependent resistor (LDR). The voltage of the power supply is changed to vary the power of the lamp to alter its brightness. The resistance of the LDR is measured with an ohmmeter (Ω) for each power of the lamp.



(a) (i) State **two** variables, **other than using the same components**, that should be controlled in this experiment. [2]

1. ....

2. ....

(ii) Explain how the design of the experiment could be improved to make the results more valid. [2]

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(b) The results are shown in the table below.

Power of lamp (W)	Resistance of LDR (kΩ)
2	19.5
4	10.3
8	3.0
12	2.2
16	1.5
20	1.3
24	1.1

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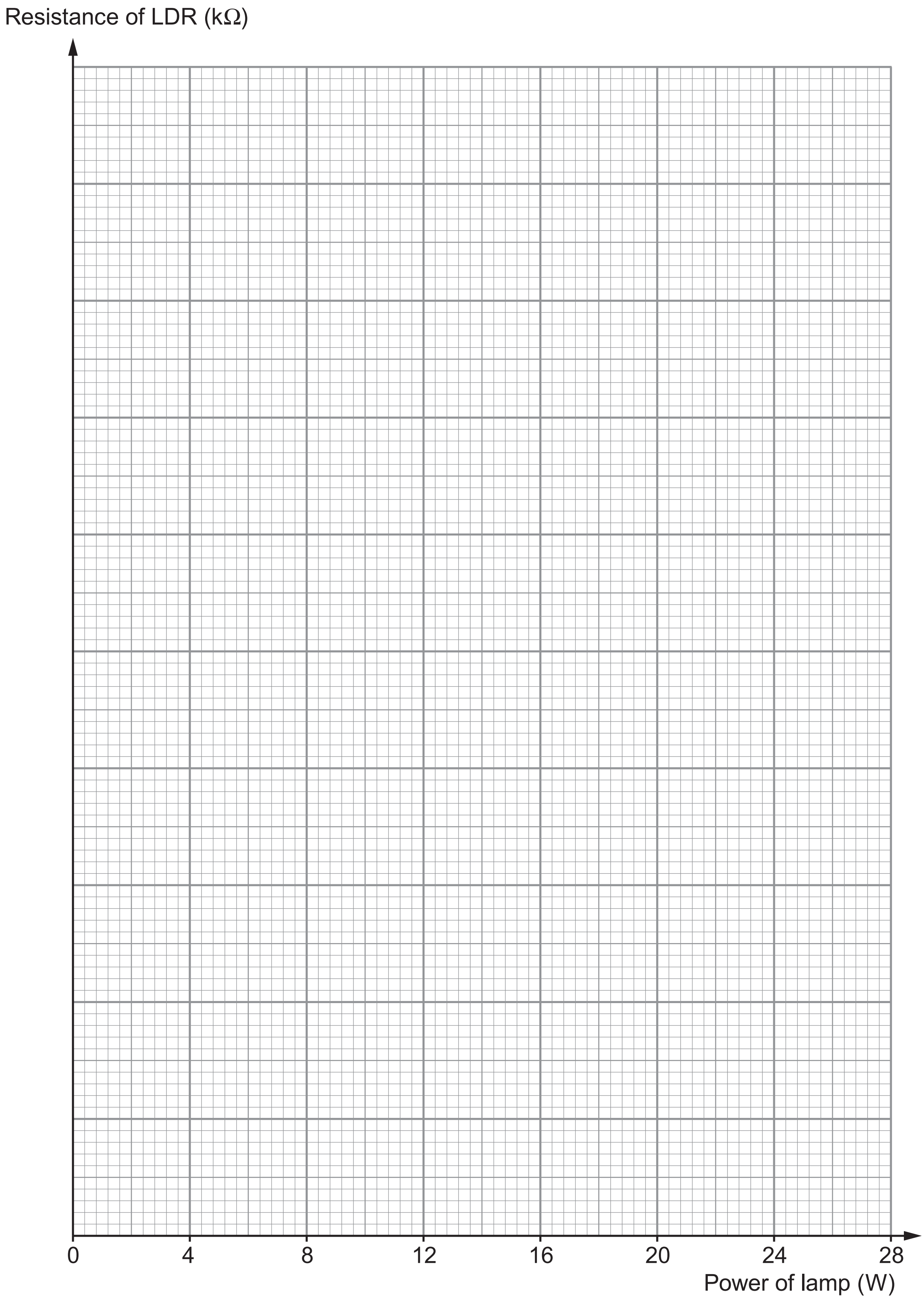
(i) Use the data to plot a graph on the grid below and draw a suitable line. [4]



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(ii) Use the graph to find the resistance of the LDR for a lamp power of 10 W. [1]

Resistance = ... Ω

(iii) It is suggested that when the lamp power doubles, the LDR resistance halves. Explain, using values from the table, to what extent this suggestion is true. [3]

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(c) The LDR is connected into another circuit. The voltage across the LDR is 2.8 V and the current through it is 0.35 mA. Use an equation from page 2 to calculate the resistance of the LDR. [3]

Resistance = ... Ω

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2. The ***epicentre*** is the point on the Earth's surface directly above an earthquake. Seismic stations detect earthquakes by the tracings made on seismographs.

(a) Surface, P and S waves are three types of earthquake waves.
Tick (✓) the boxes next to the **three** correct statements about earthquake waves. [3]

Surface waves travel the fastest	☐
S waves travel on the surface of the Earth	☐
S waves are transverse waves	☐
P waves travel through solids and liquids	☐
P waves are longitudinal waves	☐
S waves cause the most damage	☐

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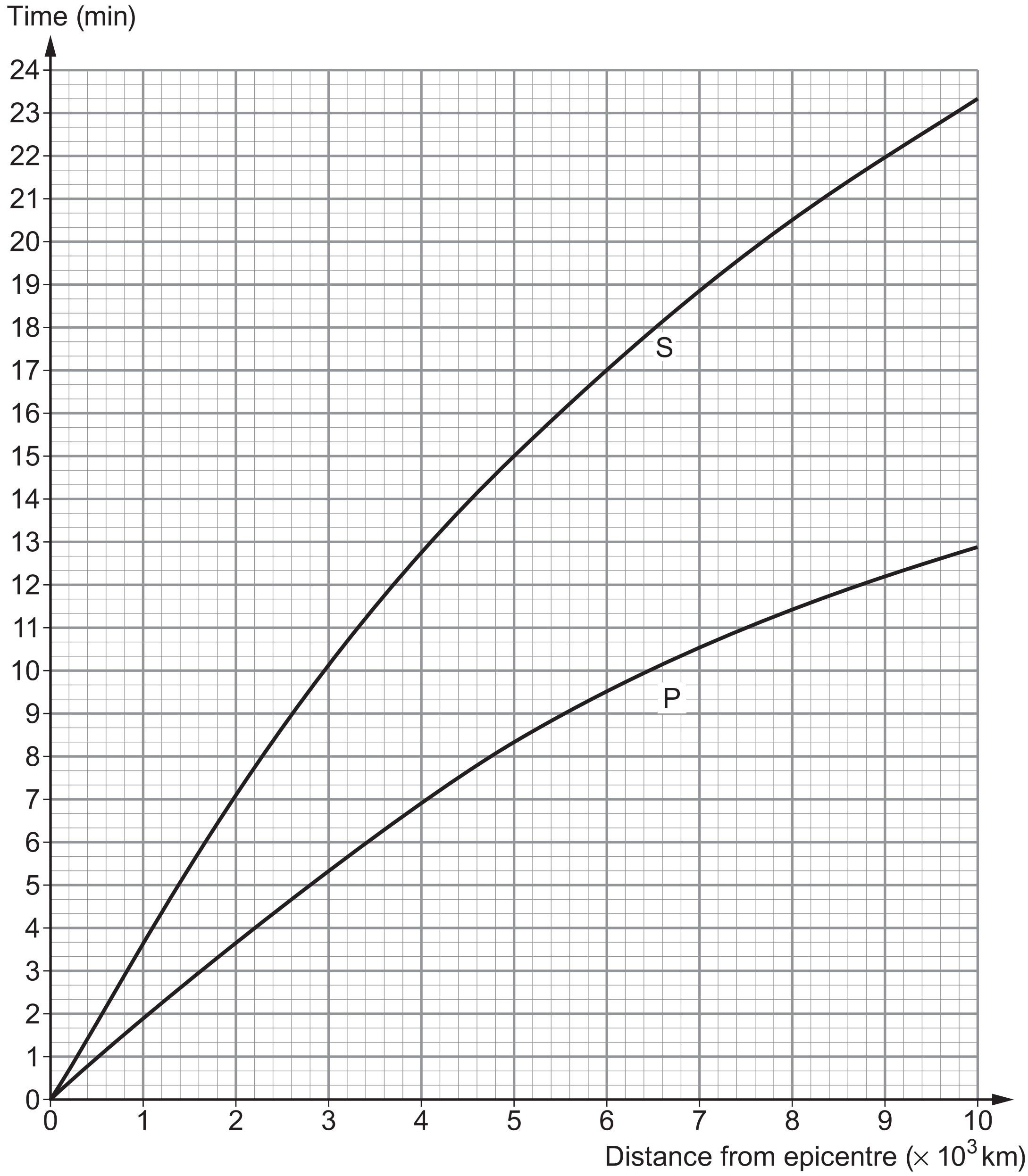
(b) The graph shows the time taken by P and S waves to travel different distances from the epicentre.



Each small square on the time axis represents 20 s.

(i) Use the graph to answer the following questions.

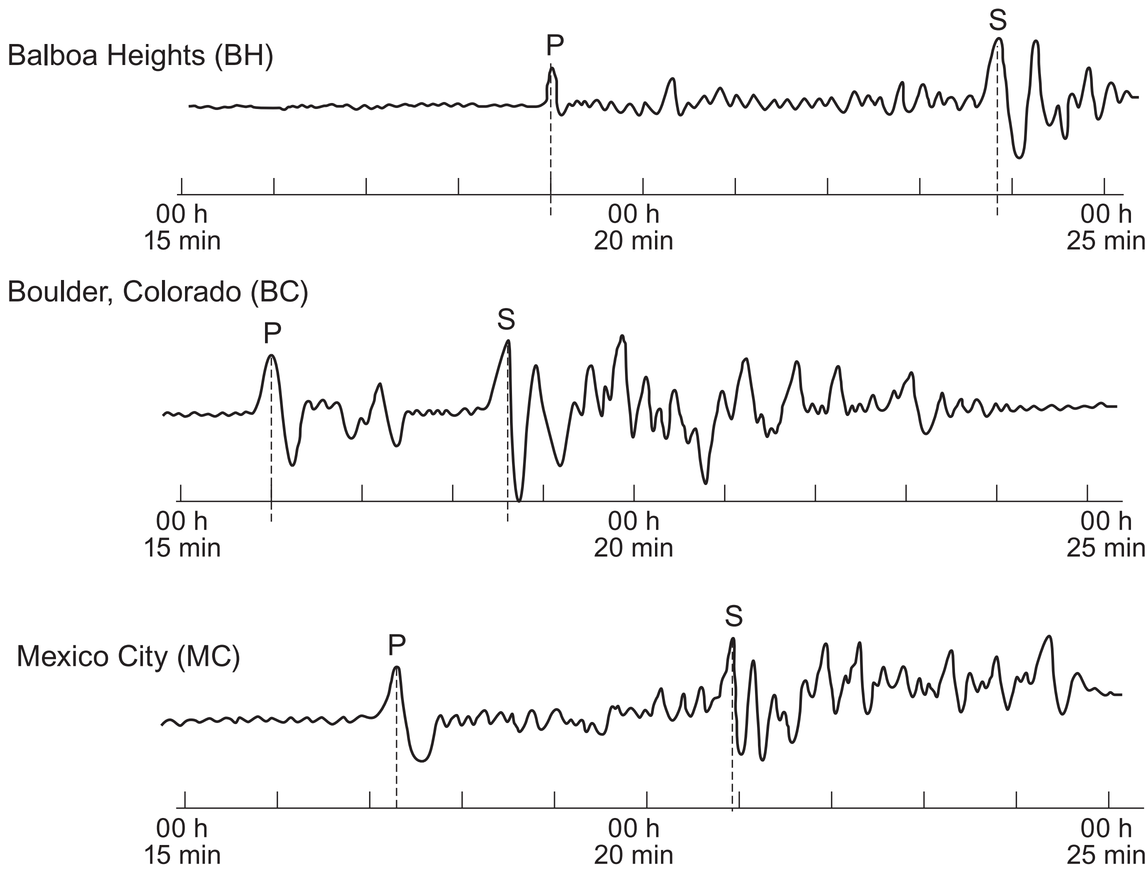
I. State the time it takes for a P wave to travel 5×10^3 km from the epicentre. [1]

time = ... min .... s

II. State the **extra** time it takes S waves to travel 5×10^3 km from the epicentre. [1]

time = ... min .... s

(ii) Study the three seismograph tracings below. Tracings made at three separate seismic stations are needed to locate an earthquake epicentre. P shows the arrival of P waves and S shows the arrival of S waves.



Use the information in the graph and tracings to **complete the table**. [3]

City	Arrival time of P waves (h:min:s)	Arrival time of S waves (h:min:s)	Time difference for P and S waves (h:min:s)	Distance to epicentre ($\times 10^3$ km)
Balboa Heights (BH)	00:19:00	00:23:50	00:04:50	3.2
Boulder, Colorado (BC)	.... : .... :	00:18:40	.... : .... :	....
Mexico City (MC)	00:17:15	00:20:55	00:03:40	2.2

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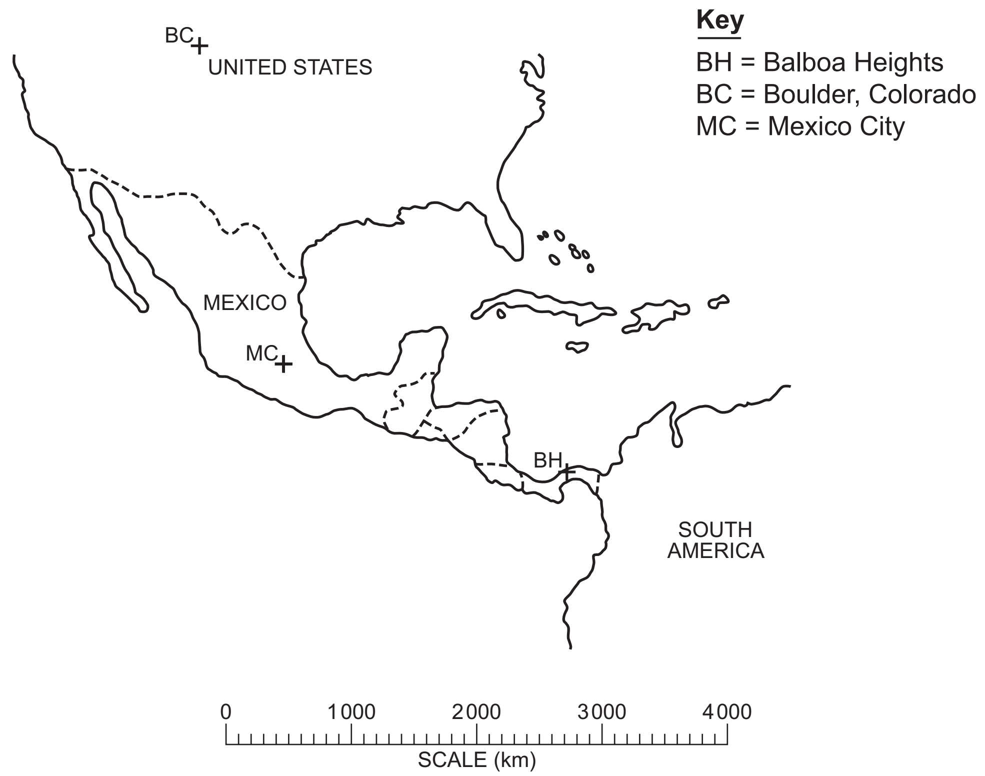
(iii) Use the data in the table to find the epicentre of the earthquake on the diagram below. [3]



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3. *(a)* Measurements from an experiment to find the density of an irregular shaped solid are given below.

Mass of the solid = 26.0 g
Volume of water in measuring cylinder = 40 cm^3
Volume of water and solid = 48 cm^3

Use an equation from page 2 and the information above to calculate the density of the solid. [3]

Density = ... g/cm^3

(b) Describe how you would change the experiment to find the density of an irregular shaped solid that floated on water. [3]

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(c) Explain in terms of particles why most solids have greater densities than water. [2]

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4. *(a)* Describe the advantages of household ring main circuits. [3]

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(b) Explain which safety device operates when the following faults occur.

(i) The ring main circuit stops working when an additional fault-free appliance is plugged into it. [2]

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(ii) The circuit stops working when a lawnmower accidentally cuts the power cable during use. [2]

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(c) Explain why electrical appliances with a metal casing require an earth lead whereas those with a plastic casing do not. [2]

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5. Satellites are used to communicate between base stations at different places on Earth.

(a) (i) **Complete the diagram** below to show how base station A communicates with base station B. [3]

(ii) Explain why a geostationary satellite must be used for constant communication rather than a geosynchronous one. [2]

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(b) A base station communicates with another base station using a single geostationary satellite 3.6×10^4 km above the Earth. They communicate with each other using microwaves of wavelength 2.8 cm travelling at 3×10^8 m/s.

Use an equation from page 2 to calculate the time delay between sending a signal from one base station and receiving the signal at the other. [4]

Time = ... s

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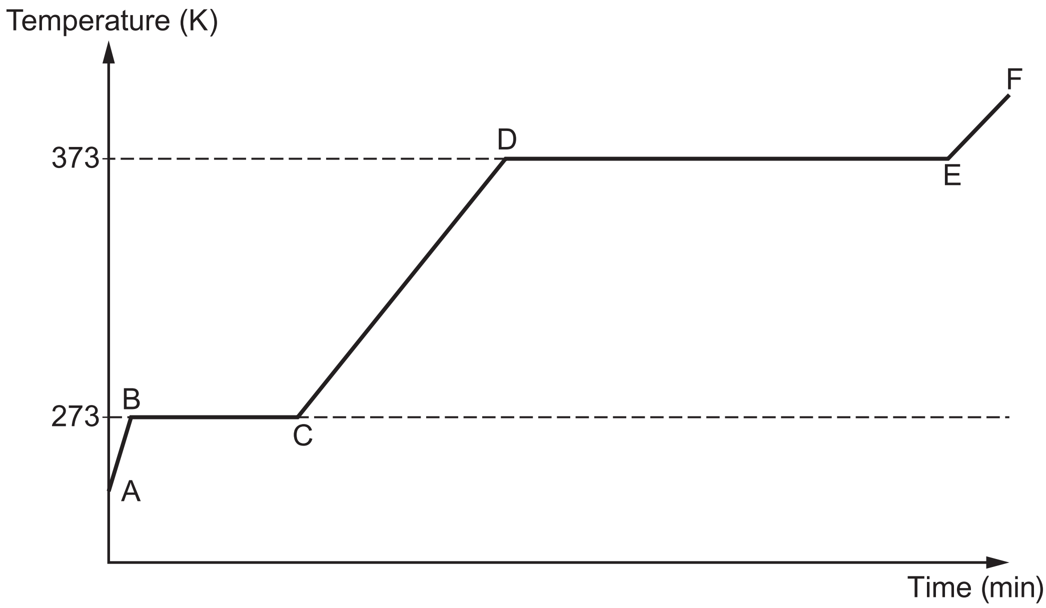
6. The graph below shows how the temperature of a block of ice changes over time as it is heated.



(a) Refer to the graph to explain the changes in temperature and changes in state of the block of ice in terms of the behaviour of molecules. [6 QER]

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(b) The specific latent heat, L, of fusion of ice is 336 000 J/kg.

(i) Explain what is meant by this statement. [2]

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(ii) The ice block has a mass of 800 g. Its initial temperature is 250 K.
Use equations from page 2 to calculate the energy required to raise its temperature to 273 K and completely melt the ice block at 273 K.
The specific heat capacity, c, of ice is 2 030 J/kg K. [5]

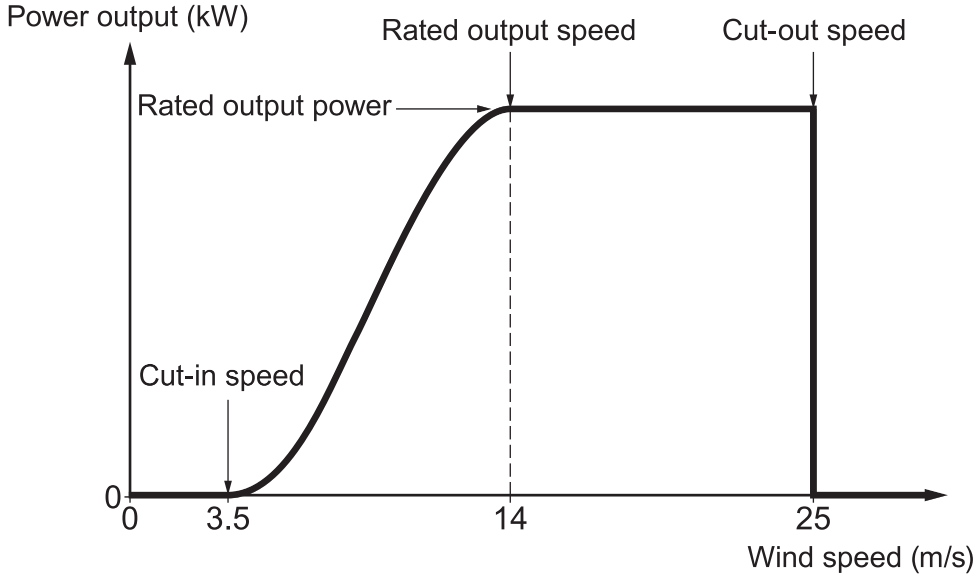
Energy = ... J

13

7. Wind turbines are mounted on towers to capture the most energy. They harness the wind's energy with their propeller-like blades. Wind turbines can be used as stand-alone applications, or they can be connected to the National Grid. For larger scale sources of wind energy, a number of wind turbines are built close together to form a wind farm. Several electricity providers today use wind farms to supply power to their customers.

(a) The power output from a wind turbine is not constant but depends on wind speed as shown in Graph 1.

Graph 1



The cut-in speed is the speed at which the turbine first starts to rotate and generate power. Somewhere between 12 and 15 m/s, the output power reaches the maximum limit. This limit is called the rated output power and the wind speed at which it is reached is called the rated output speed. As the speed increases the forces on the turbine structure continue to rise and, at some point, there is a risk of damage to the rotor. As a result, a braking system is employed to bring the rotor to a standstill. This occurs at the cut-out speed and is usually around 25 m/s.

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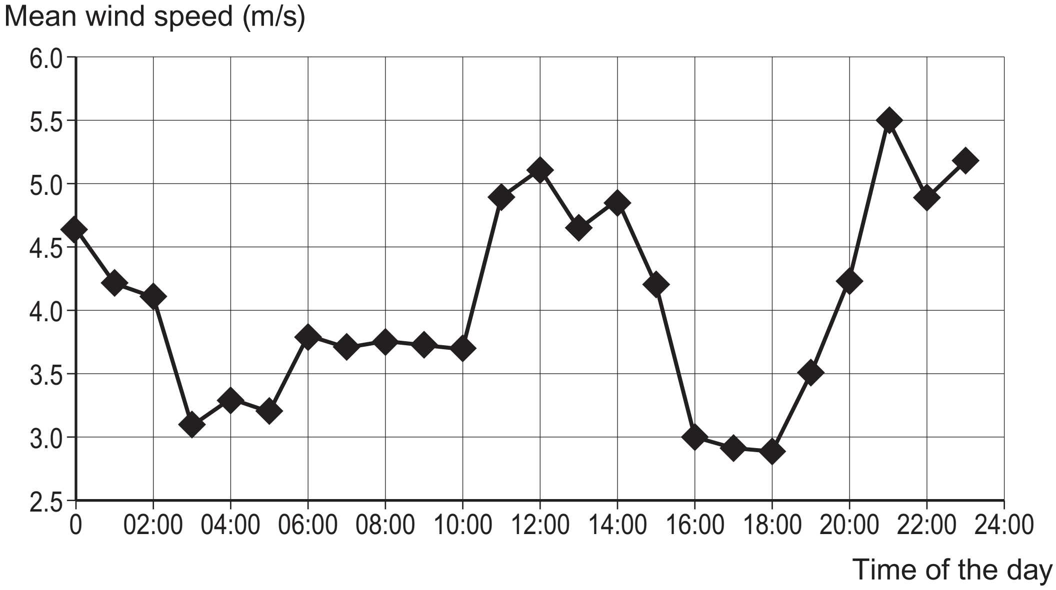
The mean wind speed for different times during one day in May are shown in Graph 2.

Graph 2



It is claimed that wind power is **always** a useful back up at times of high demand between the hours of 06:00 to 10:00 and between 16:00 to 20:00 because it is always windy.

Explain whether the information in both Graphs 1 and 2 support this claim. [4]

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TURN OVER FOR THE REST OF THE QUESTION

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(b) A wind farm off the coast of Wales, has an output voltage of 16 kV and a total rated output power of 24 MW. It is connected to the National Grid by a transformer. The transformer has an input coil containing 400 turns and an output coil containing 4 800 turns. Assume the transformer has an efficiency of 100%.

Use equations from page 2 to answer the following questions.

(i) Calculate the output voltage of the transformer in kV. [2]

Output voltage = ... kV

(ii) Calculate the output current of the transformer. [3]

Output current = ... A

(c) (i) Explain the role of transformers in the National Grid. [3]

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(ii) Explain the purpose of an iron core in a transformer **and** state why it is laminated. [3]

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