OCR
Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 2 January 2025 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from [Teach Cambridge](#).

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Unit 2 series overview

Unit 2: Science for Engineering is an externally assessed unit of study which is a mandatory part of all the routes through the Cambridge Technical Level 3 Engineering qualifications.

It consists of six questions covering all of the learning objectives of the specification with a range of contexts including fairground rides, building construction and central heating.

In this series, candidates seemed to perform better on questions covering simple capacitance circuits (Question 3 (a)) and mechanical behaviour of beams (Question 4). Candidates did less well on topics such as viscosity (Question 5 (a)) and graphical representation of kinematics (Question 2).

For numerical questions, candidates should be encouraged to write down the equation as the first step and then lay out their substitution and evaluation clearly. It would also be helpful to note the units given in the stem of the question and relate those to the units given on the answer line to ensure consistency.

There were a number of questions on graphical work in this paper. In Question 2, candidates were asked to sketch a displacement-time graph and a velocity-time graph for a swinging object. It was important for candidates to draw lines carefully. In Question 3, candidates were asked to draw the discharge curve for a capacitor, and because the axes were labelled, it was important for them to identify key points on the graph such as the starting point. In Question 5, candidates had to read off some coordinates from the graph, for which they needed to carefully check the scale markings.

In questions where candidates are asked to explain scientific terms or phenomena, it would be best for them to use scientific terminology correctly and structure their response in a logical format.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
- took care to draw and read graphs correctly - used scientific terminology in the correct contexts - laid out calculations clearly.	- showed limited understanding of viscosity (specification point 5.8) - did not convert units to SI units in calculation questions.

Question 1 (a)

1

**(a)** Complete the table of SI derived quantities and their units.

Unit	SI derived quantity
J	energy
Pa	
Hz	
Wb	

[3]

Most candidates showed that they were familiar with the units Pa and Hz, correctly identifying that these are used to measure pressure and frequency. Candidates tended to be less familiar with the unit Wb, but many did attempt to answer this part. There were also several instances where candidates wrote out the name of the units in full, which was not what was asked.

Question 1 (b) (iii)

(iii) The diagram shows the end of the steel ruler.
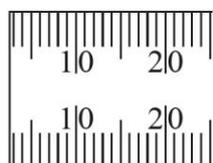
Suggest what absolute correction should be applied to readings from this steel ruler.

Absolute correction = ... mm **[2]**

Very few candidates answered this question correctly. Many wrote out the equation 'absolute correction = true value – indicated value', but then did not interpret it correctly. The end of the ruler has been worn away by about 2.5 mm, so any reading would be larger than the actual length. For example, if we read off the ruler a length of 20 mm (indicated value), the true length would be 17.5 mm. Using the equation would then give an absolute correction of – 2.5 mm. Most candidates did not give a negative value.

Question 1 (c)

(c) The cable contains steel armour wires to protect the inner copper wires from being cut-through accidentally, for example, by a garden spade.

Which **two** properties of steel make it suitable for this job?

Tick (✓) **two** boxes.

| Property	Tick
ductile	
elastic	
good electrical conductor	
malleable	
strong	

[2]

Many candidates chose the correct properties here. Some candidates ticked malleable, which, although also concerning large amounts of plastic deformation, is not the same as ductile. Some candidates selected 'good electrical conductor', which would be a suitable property for the copper wires rather than the protective outer steel coating.

Question 2 (a)

2   This question is about some fairground rides.

(a) The graph shows how the displacement of a car on a fairground ride changes with time.
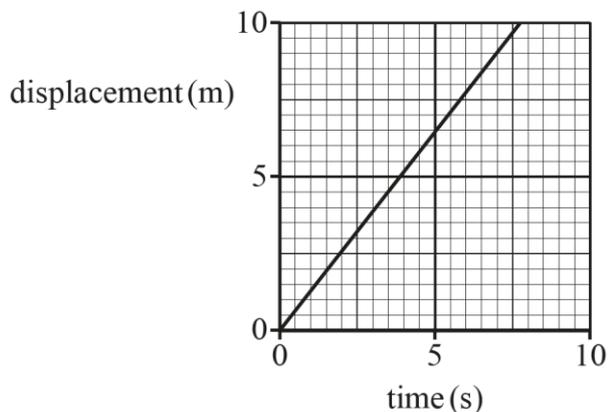
Use the graph to find the velocity of the ride.

Include the unit in your answer.

Velocity = ... Unit .... **[3]**

Most candidates used a correct method to calculate velocity, but some misread the scale on the graph. Some candidates wrote an incorrect unit, with m/s^{-1}, m s^{-2} and m s being the common incorrect responses.

Question 2 (b) (i)

(b) The diagram shows a pirate ship ride. The dashed lines mark the centre of the pirate ship, which moves from A through B to C and back again.
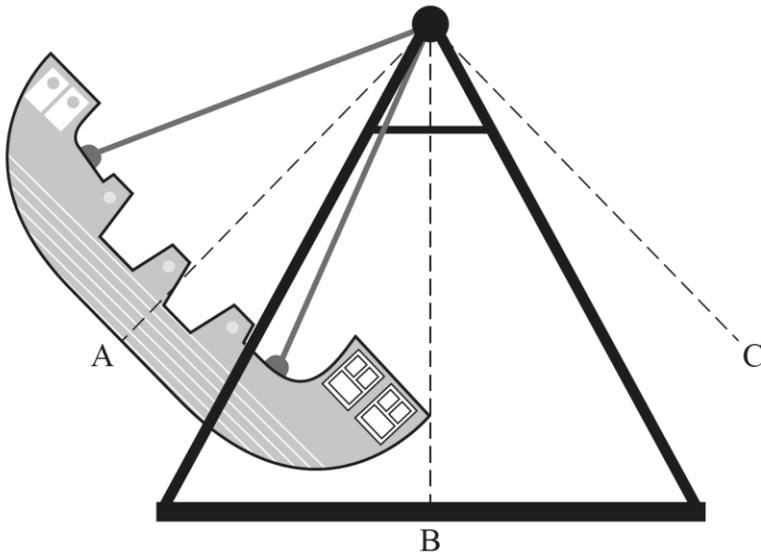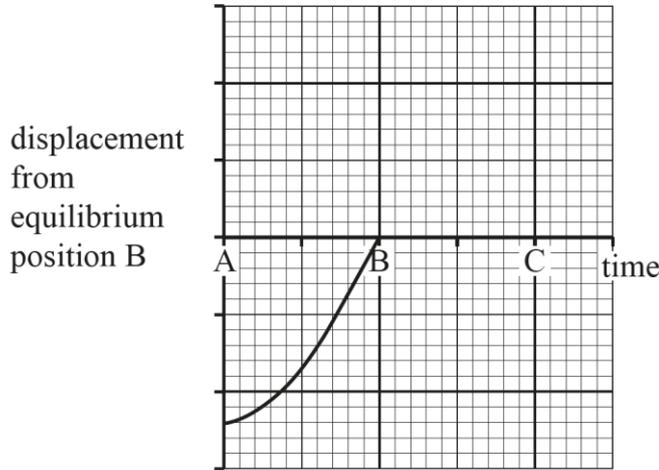

(i) Define **displacement**.

....

....

.... **[2]**

Most candidates stated that displacement was a distance moved by an object, but rarely also included that it had a direction. Common responses included 'how far an object has moved from its original position', which does not explicitly suggest that it has a specific direction.

Question 2 (b) (ii)

The graph shows how the displacement of the pirate ship varies with time as it moves from position A to its equilibrium position B.


(ii) Draw a curve on the graph above to show the displacement of the ship as it continues from position B to position C. **[2]**

Many candidates drew the correct shape curve to show the displacement from B to C, but many did not get up to the maximum of 12 small squares at point C.

Question 2 (b) (iii)

(iii) Sketch on the axes below a graph to show the velocity of the ship as it moves from positions A to B to C.
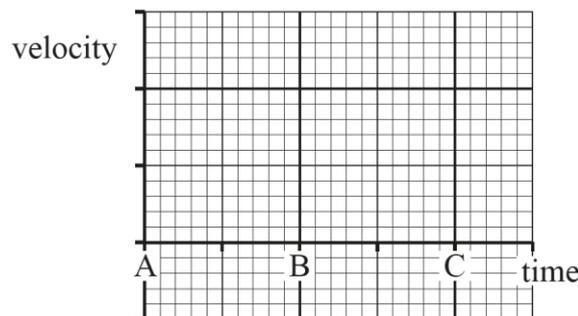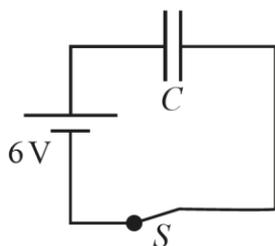

[3]

Many candidates correctly showed the velocity increasing from A to B, but some just drew a straight line rather than one with decreasing positive gradient. Most candidates were able to show that the velocity would then decrease in the opposite way from B to C.

Question 3 (a) (i)

3

(a) The diagram shows a circuit with a 6 V cell, a capacitor, *C*, and a switch, *S*.

When the switch is closed there is an electric current in the wire.

(i) Define electric current.

....

.... **[2]**

Many candidates were able to define electric current as the rate of flow of charge or electrons. Some candidates used the Ohm's law relationship to say that current was voltage divided by resistance, which, while being algebraically correct, is not a definition of electric current. Other common errors included terminology such as 'flow of electricity' or 'how power is passed through the circuit'.
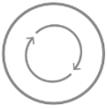
Question 3 (a) (ii)

(ii) An average current of 1.3 mA flows for 1 minute until the capacitor is fully charged.

Calculate the charge stored on the capacitor. Give your answer in mC.

Charge = ... mC **[3]**

Most candidates correctly calculated the charge including converting the time to 60 seconds. Some candidates converted the current to A and then multiplied by the time, and then had to convert their final answer back into mC.

> ### Assessment for learning
>
> If the units are given on the answer line for a calculation question, it is a good idea for candidates to look carefully to avoid unnecessarily converting values into SI units.
>
> In Question 3 (a) (ii), the current is given in mA and the answer needs to be given in mC so there is no need to convert the current into A on this occasion, only to then convert the answer in C into mC.

Question 3 (a) (iii)

(iii) State why the potential difference between the plates when the capacitor is fully charged is 6 V.

....

.... **[1]**

Many candidates recognized that the fully charged capacitor would have a potential difference equal to the emf across the cell. Common errors included suggesting that 6V was the maximum potential difference across the capacitor or misusing terms such as power in this context.

> ### Assessment for learning
>
> It is important to use correct scientific terminology. Many common words have specific meaning in the context of electrical and electronic engineering.
>
> For example, in everyday language we might talk about the power of a battery being 6V, but this is not scientifically correct. 6V is the electro-motive force or the potential difference across the cell when no current is flowing. Power is the rate of doing work and could be found by multiplying potential difference by current, and is measured in Watts.

Question 3 (a) (iv)

(iv) The distance between the two plates of the capacitor is $20\,cm$.

Calculate the electric field strength, in $V\,m^{-1}$, between the plates.

Field strength = ... $V\,m^{-1}$ **[2]**

Most candidates demonstrated the correct method to find the electric field strength, but some did not convert the distance of 20 cm into 0.20 m to give their answer in Vm^{-1}.

Question 3 (b)

(b) The charged capacitor is then discharged through a resistor.

Sketch on the axes below the graph of potential difference across the capacitor against time, as the capacitor is discharged.

The time constant, τ, for the capacitor and resistor is $1.0\,\text{s}$.
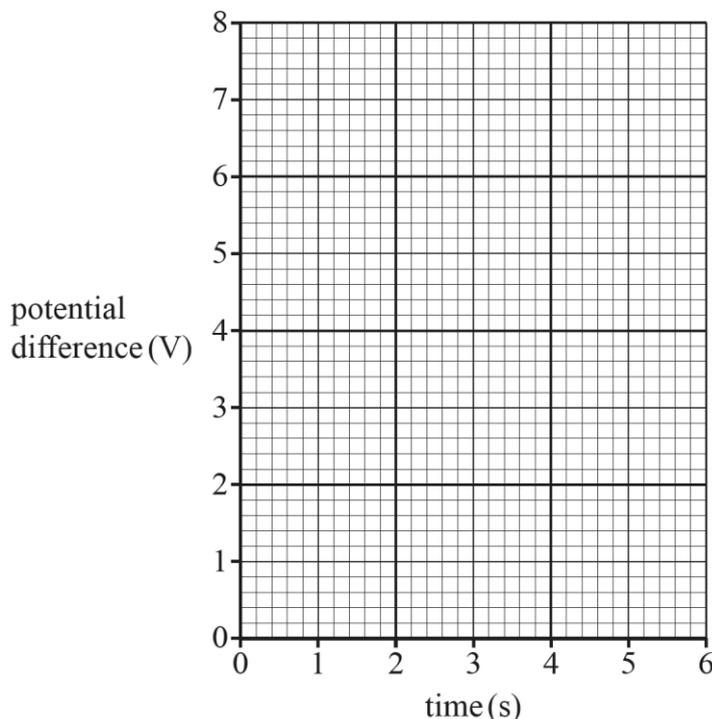

[3]

Most candidates did not draw the correctly shaped graph in their response. Some candidates drew an upwards curve or a horizontal line, so did not recognize that the potential difference across a capacitor will decrease when it is discharging. Some candidates did not start their curve at the correct potential difference.

Exemplar 1

(b) The charged capacitor is then discharged through a resistor.

Sketch on the axes below the graph of potential difference across the capacitor against time, as the capacitor is discharged.

The time constant, τ, for the capacitor and resistor is 1.0 s.
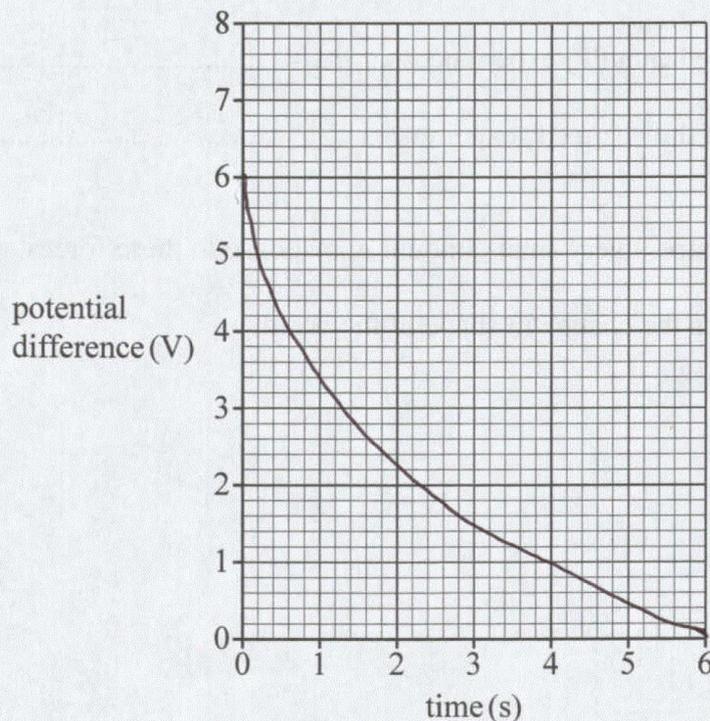
[3]

This candidate correctly started the line at 6V. The curve drawn shows the correct trend, decreasing steeply at first and then flattening out as the capacitor becomes discharged. Candidates were told that the time constant of the capacitor was 1.0s. Because capacitors discharge exponentially, the potential difference should have reduced to approximately a third of the initial potential difference after one time period, which means that graph in this exemplar is not steep enough at the beginning. The graph after one time period should have been closer to the point (1.0, 2.2).

Question 4 (b)

(b) A steel beam experiences tensile stress of 600 MPa.

Calculate the strain.

Young's modulus of steel is 210 GPa.

Give your answer as a **percentage** with **2** significant figures.

Strain = ...% **[4]**

Most candidates started by correctly substituting the values into the equation, but some candidates did not convert the values of stress and Young Modulus.

Exemplar 2

(b) A steel beam experiences tensile stress of 600 MPa.

Calculate the strain.

Young's modulus of steel is 210 GPa.

Give your answer as a **percentage** with **2** significant figures.

$$YM = \frac{stress}{strain} \times 100$$

$$210G = \frac{600M}{strain}$$

$$\frac{600 \times 10^6}{210 \times 10^8} = 0.02857$$

$$= 2.86 \times 10^{-4} \%$$

Strain = ...2.86×10^{-4}............% **[4]**

This candidate started well by writing down the equation. They then clearly substituted the correct values into the equation, which were 600M for the stress and 210G for the Young Modulus. The candidate then attempted to convert the values to SI units, but got the power of 10 incorrect as GPa should be ×10[9]. Then they divide by 100 instead of multiplying by 100 to find the value as a percentage. They were asked to give the response to two significant figures, but this value has been left in three significant figures. It is good to see the working in this calculation clearly laid out so the examiner knows what the candidate is doing.

Question 4 (c)

(c) At the end of the manufacturing process destructive tests are carried out on sample beams.

Describe **one** benefit of destructive testing.

....

.... **[1]**

Most candidates answered that it is possible to obtain values for properties such as ultimate tensile strength or yield strength. Some candidates were not specific enough and gave vague responses, including 'destructive testing can be used to find the limits of the material'.

Questions 5 (a) (i) and (ii)

5 Oil is a viscous liquid used as a lubricant in car engines.

There are two main ways to describe the viscosity of oil: dynamic viscosity and kinematic viscosity.

(a)

(i) Complete the formula to give the definition of dynamic viscosity.

Use words from the list below.

Density gradient	**Force gradient**	**Shear force**
Shear strain	**Shear stress**	**Velocity gradient**

$$\text{Dynamic viscosity} = \frac{\text{..}}{\text{..}}$$

[2]

(ii) Describe the difference between kinematic and dynamic viscosity.

....

.... **[1]**

Most candidates did not seem familiar with the definitions of kinematic and dynamic viscosity at specification point 5.8.

Question 5 (b)

(b) The graph shows how the kinematic viscosity of the oil changes with temperature.
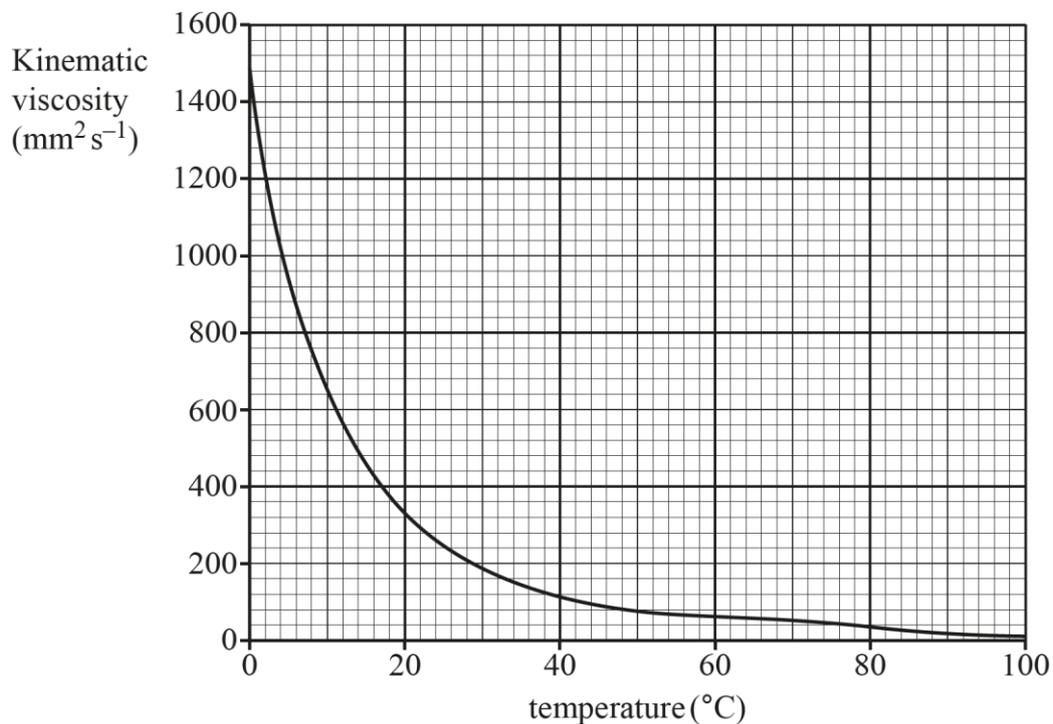
State the change in kinematic viscosity of the oil when the temperature increases from 15 °C to 45 °C.

Change in kinematic viscosity = ... $mm^2 s^{-1}$ **[1]**

Many candidates were able to read the two coordinates from the graph and subtract them. Some candidates misread the temperature scale and used 10°C as the value of kinematic viscosity instead of 15°C.

Question 5 (c)

(c) The oil helps to prevent the engine from getting too hot by absorbing heat energy from the engine.

The specific heat capacity of the oil is $2180\,\mathrm{J\,kg^{-1}\,K^{-1}}$.

Calculate the heat energy absorbed by $1.0\,\mathrm{kg}$ of the oil when its temperature increases from $10\,°\mathrm{C}$ to $40\,°\mathrm{C}$.

Energy absorbed = ... J **[2]**

Most candidates used the correct equation to find the energy absorbed, but some candidates attempted to convert the temperature change to Kelvin.

Question 6 (a) (i)

6   A heating engineer is called out to a house because one of the central heating radiators feels cold at the top.

(a)   The engineer determines that there is air trapped above the water inside the radiator, as shown in the diagram below.

Air space

Water
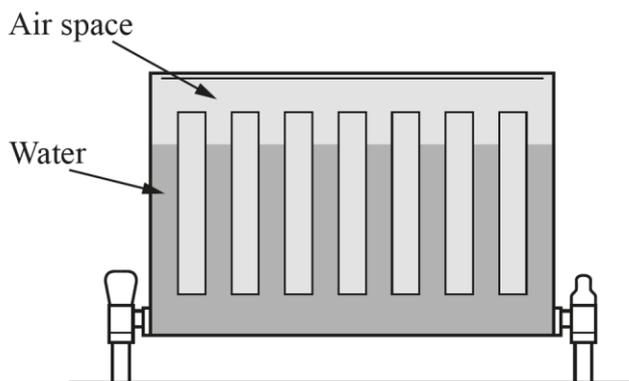
(i)   There are 0.1 moles of air at 50 °C taking up 0.002 m³ in the radiator.

Calculate the pressure of the air.

Molar gas constant, $R = 8.3 \, \text{J K}^{-1} \text{mol}^{-1}$

Air pressure = ... Pa **[3]**

Most candidates started correctly by using the ideal gas equation, but some candidates did not convert the temperature to Kelvin. Some candidates also just ended up calculating PV, rather than pressure.

Should Kelvin or °Celsius be used for the temperature in this calculation?

Some candidates are confused about whether to use Kelvin or °Celsius when temperatures are used in calculation question.

The Kelvin and the °Celsius temperature scales have the same step size, so whenever a temperature difference is used there is no need to convert from °Celsius.

All the gas laws use the absolute temperature scale, so all temperatures must be in Kelvin.

Question 6 (a) (ii)

(ii) Explain what happens to the volume of air if the pressure is doubled but the temperature remains the same.

....

.... **[2]**

Most candidates did suggest that the volume would decrease, but did not give a correct explanation.

Exemplar 3

(ii) Explain what happens to the volume of air if the <u>pressure is</u> doubled but the temperature remains the same.

Volume of air will half because
as pressure increases so does temperature. **[2]**

$$PV = nRT$$
$$\times 2$$

This exemplar correctly stated that the volume would halve, but the explanation is incorrect. The candidate appropriately wrote down the ideal gas equation and stated that pressure would increase with increase in temperature, but this was not what was asked for this question. The candidate should have recognized that when the temperature remains the same, the value of *nRT* would be constant, and therefore pressure *P* is inversely proportional to volume *V*.

Question 6 (b) (i)

(b) The engineer wants to find out if the heating system is effective.

They measure the energy put into the heating system by the boiler over 1 hour.

The energy input to the heating system is 1.2 kWh.

(i) Use the non-flow energy equation to calculate the energy transferred out of the heating system and into the surroundings.

Assume the initial and final energy of the heating system is the same.

Give your answer in megajoules (MJ).

Energy transferred = ... MJ **[3]**

> Most candidates recognized that the value of energy transferred out of the system will be the same as the energy transferred, but did not show the correct working from the non-flow energy equation. Many candidates incorrectly stated that the initial energy (U_1) and the final energy (U_2) were both equal to zero, rather than the difference ($U_2 - U_1$) = 0. Most candidates left their final answer in kWh rather than convert to MJ.

Question 6 (b) (iii)

(iii) The pressure gauge on the boiler reads 1.3 bar.

Atmospheric pressure is 101 kPa.

1 bar = 100 kPa

Calculate the absolute pressure in the boiler.

Absolute pressure = ... kPa **[2]**

> Most candidates correctly converted the gauge pressure of 1.3 bar to 130 kPa, but some candidates then subtracted the atmospheric pressure from the gauge pressure, instead of adding the two values together.

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Online courses

Enhance your skills and confidence in internal assessment

What are our online courses?

Our online courses are self-paced eLearning courses designed to help you deliver, mark and administer internal assessment for our qualifications. They are suitable for both new and experienced teachers who want to refresh their knowledge and practice.

Why should you use our online courses?

With these online courses you will:

- learn about the key principles and processes of internal assessment and standardisation

- gain a deeper understanding of the marking criteria and how to apply them consistently and accurately

- see examples of student work with commentary and feedback from OCR moderators

- have the opportunity to practise marking and compare your judgements with those of OCR moderators

- receive instant feedback and guidance on your marking and standardisation skills

- be able to track your progress and achievements through the courses.

How can you access our online courses?

Access courses from Teach Cambridge. Teach Cambridge is our secure teacher website, where you'll find all teacher support for your subject.

If you already have a Teach Cambridge account, you'll find available courses for your subject under Assessment - NEA/Coursework - Online courses. Click on the blue arrow to start the course.

If you don't have a Teach Cambridge account yet, ask your exams officer to set you up – just send them this link and ask them to add you as a Teacher.

Access the courses **anytime, anywhere and at your own pace**. You can also revisit the courses as many times as you need.

Which courses are available?

There are **two types** of online course: an **introductory module** and **subject-specific** courses.

The introductory module, Building your Confidence in Internal Assessment, is designed for all teachers who are involved in internal assessment for our qualifications. It covers the following topics:

- the purpose and benefits of internal assessment

- the roles and responsibilities of teachers, assessors, internal verifiers and moderators

- the principles and methods of standardisation

- the best practices for collecting, storing and submitting evidence

- the common issues and challenges in internal assessment and how to avoid them.

The subject-specific courses are tailored for each qualification that has non-exam assessment (NEA) units, except for AS Level and Entry Level. They cover the following topics:

- the structure and content of the NEA units

- the assessment objectives and marking criteria for the NEA units

- examples of student work with commentary and feedback for the NEA units

- interactive marking practice and feedback for the NEA units.

We are also developing courses for some of the examined units, which will be available soon.

How can you get support and feedback?

If you have any queries, please contact our Customer Support Centre on 01223 553998 or email support@ocr.org.uk.

We welcome your feedback and suggestions on how to improve the online courses and make them more useful and relevant for you. You can share your views by completing the evaluation form at the end of each course.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

👍 **I like this**   👎 **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.