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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 can be downloaded from OCR.

Paper R101 series overview

R101 is one of four units that make up the Cambridge National in Principles of Engineering Business. Candidates will either work towards the Award to complete R101 and R102, or the Certificate by completing R101, R102, R103, and R104. R101 is the only externally examined unit with the other units being centre assessed. To do well on this examination paper, candidates will have needed to gain knowledge and understanding of mechanical, electrical and fluid power systems and be able to apply this in a written description of practical applications, including integrated power systems.

Many candidates attempted most of the questions on the paper, although there were exceptions amongst some lower ability candidates, and where candidate were required to label diagrams.

Candidate performance varied across the range of abilities. Some part questions were answered well across the ability range and likewise there were parts which were less well answered. As in previous series, a much higher than expected number of candidates omitted to answer questions which required the candidates to add one or more labels to diagrams. This appears to be due to candidates having overlooked the need to read instructions to part questions where there is not an answer line, before moving to the next question.

Candidate performance overview

Parts which candidates answered well	*Parts that were less well answered*
• Explaining how the hammer used as a lever is different to a wheelbarrow. 1(a)(iv) • Giving an application of a hand tool used to give mechanical advantage. 1(b)(ii) • Using given terms to describe the operation of the vacuum generator. 3(a)(ii) • Giving benefits of using vacuum power in food manufacturing. 3(c) • Stating which gear is the idler gear. 4(a) • Giving one hydraulic application. 6(a)(ii)	• Explaining what happens when a current is applied to the relay. 2(a)(iii) • Stating how the direction of the motor can be reversed. 4(c)(iii) • Explaining how components shown are used to control the operation of the door. 5(a)(ii) • Giving the meaning of the term 'main air'. 5(a)(iv) • Naming a component that could be used to control the solenoid valve. 6(a)(iii) • Discussing the benefits of using electrical systems to control pneumatic applications in engineering. 6(b)*

Candidates generally performed less well on the parts involving calculations compared to recent previous series of R101. Candidates were able to correctly use the information given to perform calculations for Ohm's Law in part 2(a)(ii), but mostly did not show understanding of the units for current. This was necessary to be able to be credited with the full marks. In part 4(a)(iii), many candidates correctly calculated the velocity ratio numerically, but were unable to present this as a ratio. Centres are advised to ensure candidates are prepared to be able to state the units, and correctly format their answers, as this forms an important part of demonstrating understanding within Learning Outcome 1 of the unit.

Once again, there were three questions which had a higher incidence of failing to answer (No Response) than anticipated. For questions 1(a)(i), 3(a)(i) and 5(a)(v) candidates were required to annotate a diagram, but could have missed the instruction to do so. This is despite clear instructions that were used to make it clear to candidates that they need to annotate the drawing, such as "Add one label to Fig 3". Many marks were lost by candidates where they did not answer these three questions. It is most important that candidates take the time to read through the question paper carefully before attempting to answer questions, and ensure that they have responded to all questions including annotating diagrams where required.

Question 1(a)(i)

1 Fig. 1 shows a hammer used as a lever.

(a) **(i)** Add **two** labels **to** Fig. 1 to show the position of the Effort and the position of the Load.

[2]

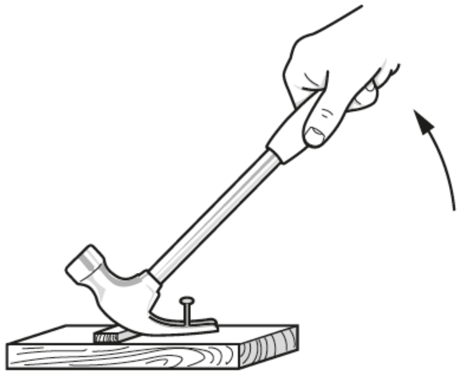


Fig. 1

This is one of three questions which a much greater number of candidates than would be expected did not answer at all (no attempt). Where candidates did answer, the majority were able to correctly label the lever showing the effort and the load. Although not required to do so, some candidates found it helpful to use free space around Fig.1 to draw examples of different class levers, to check their own understanding for this parts question, part 1(a)(ii) & (iii) (as demonstrated in exemplar 1).

Exemplar 1

[2]

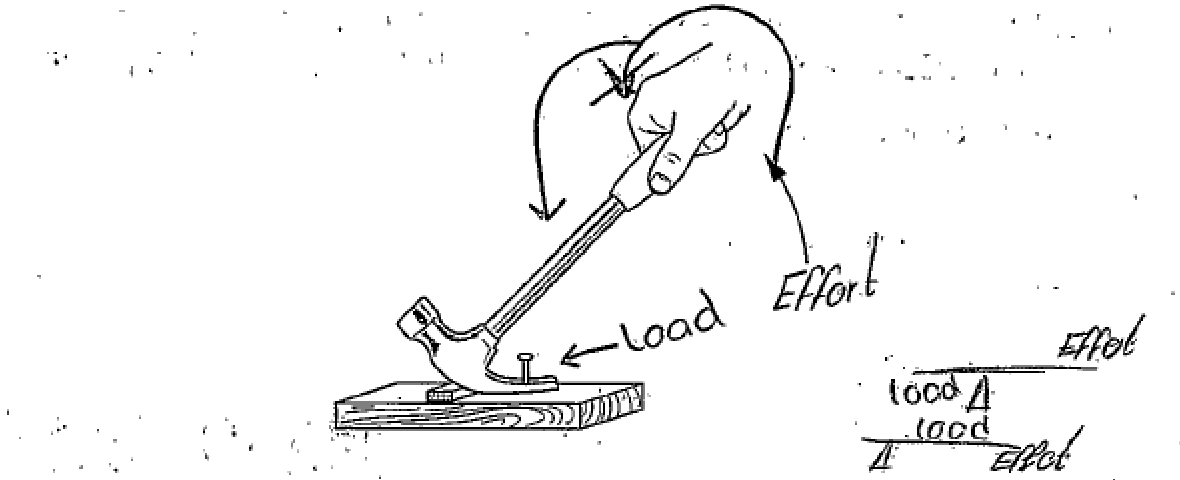


Fig. 1

Question 1(a)(ii)

(ii) State the class of lever represented by the hammer being used in Fig. 1.

.... **[1]**

About half of the total candidates gave the correct answer for the class of lever in Fig. 1.

Question 1(a)(iii)

(iii) Give **two** ways to improve the efficiency when using a hammer to remove nails as shown in Fig. 1.

1 ....

2 .... **[2]**

Most candidates were able to give at least one correct answer to this part; the majority correctly stating "make the handle longer", or similar responses.

Question 1(a)(iv)

(iv) Explain how the hammer used as a lever is different to a wheelbarrow used to carry a load.

....

....

.... **[2]**

Many candidates were able to give answers showing some understanding of the differences in the lever types. Answers ranged from those which were simplistic to relatively detailed explanations of both types of lever.

Exemplar 2

the hammer is a class 1 lever because the fulcrum is inbetween the load and the effort. the wheel barrow is a class 2 lever be cause ~~is~~ is the ~~fulcrum is~~ in~~between the~~ the load is in the middle **[2]**

Explain what is meant by the term 'mechanical advantage'

In this exemplar, the candidate has explained the position of the load, effort and fulcrum on each class of lever, and has included the class of lever represented by each.

Question 1(b)(i)

(b) (i) Explain what is meant by the term 'mechanical advantage'.

....

....

.... **[2]**

Relatively few candidates gave technical answers, but the majority were able to be credited with at least one mark for correctly stating the use of a lever or mechanism to reduce the effort.

Question 1(b)(ii)

(ii) Give **one** application, other than a hammer, of a hand tool used to give mechanical advantage.

.... **[1]**

Most candidates were able to correctly give another example of a hand tool.

Question 2(a)(i)

2 **(a)** Fig. 2 shows a direct current (DC) electro–mechanical relay.

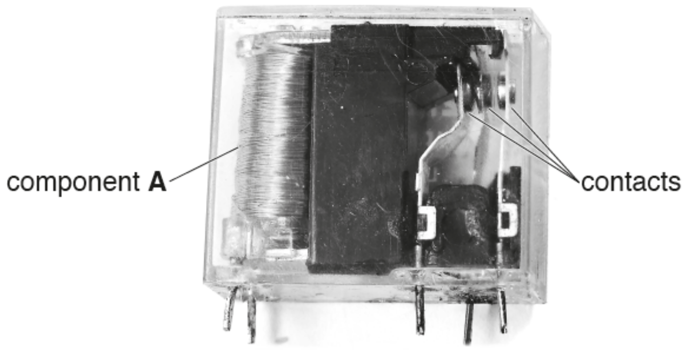


Fig. 2

(i) Name component **A** shown in Fig. 2.

.... **[1]**

Although many candidates correctly identified component A was the coil, simplistic answers such as "copper wire" were prevalent.

Question 2(a)(ii)

(ii) Component **A** has an operating voltage of 12 V and a resistance of 60 ohms.
Calculate the current draw of component **A**. State the unit in your answer.

....

....

.... **[3]**

Many candidates were able to correctly calculate the current drawn by the relay, but relatively few also stated the units to gain the full marks available. Generally, fewer candidates were able to correctly complete Ohm's Law calculations in this paper compared to recent series of R101.

Exemplar 3

V/I·R 12 ÷ 60 = 0.2

....

....

.... [3]

In this exemplar, the candidate has correctly calculated the current drawn but has omitted to include the units, and therefore has been credited 2 out of the available 3 marks for their answer.

Question 2(a)(iii)

(iii) Explain what happens when a current is applied to component **A**.

....

....

....

.... **[3]**

AfL: This part was poorly answered by most candidates with most only achieving one mark for as simplistic answer of the current flowing through the coil. Candidates demonstrated a lack of knowledge of relays in this part question and particularly in part (iv).

Question 2(a)(iv)

(iv) Give **two** reasons why the device shown in Fig. 2 would be used in a circuit.

1 ....

2 ....

[2]

Very few candidates were able to correctly give one reason for using the relay in the circuit.

Question 2(a)(v)

(v) Name **one** other DC electro–mechanical device.

.... **[1]**

AfL: Much fewer than expected candidates gave correct answers to this part. There are only three examples given within the specification, however candidates were given credit where their answers included an application using a DC motor.

Question 3(a)(i)

3 **(a)** Fig. 3 shows a vacuum generator.

(i) Add **one** label **to** Fig. 3 to show the intake port. **[1]**

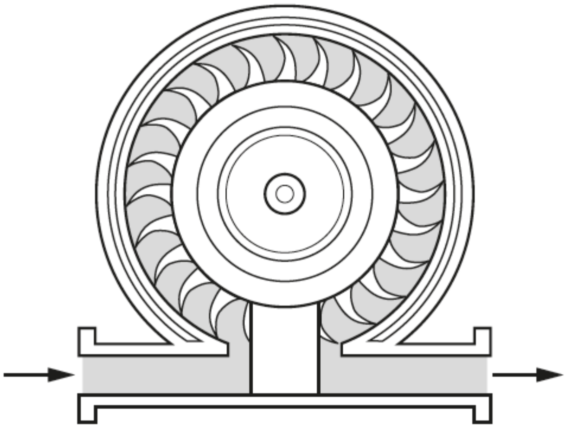


Fig. 3

This question is the second part within this examination paper with a much greater number of 'no attempts' than expected. Where candidates did answer, nearly every candidate answered correctly. Candidates need to take greater care in reading the entire question content to ensure they observe and follow the instructions given, to avoid marks being lost.

Question 3(a)(ii)

(ii) Use the terms below to complete the statement describing the operation of the vacuum generator.

Suction **ambient air pressure** **friction** **pressure drop**

The pressure outside the vacuum is the ....

The turning fan creates a .... in the area behind the fan, below the pressure level outside the vacuum generator. This creates .... and a partial vacuum, inside the vacuum generator. **[3]**

This question was well answered by the majority of candidates who were able to give at least two correct answers.

Question 3(b)

(b) Describe how a vacuum power source could be used in manufacturing, other than for cleaning.

....

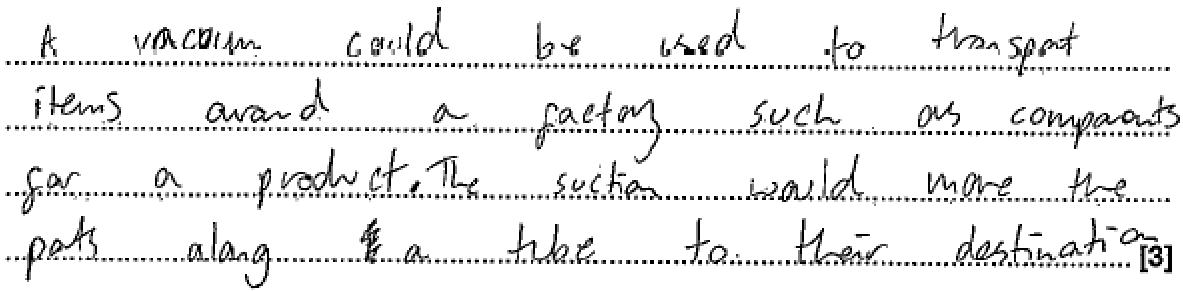
....

....

.... **[3]**

Candidates performed well in this part with many candidates demonstrating how vacuum can be used in manufacturing. Answers given mostly related to packaging, forming and extraction. Answers that included a detailed description of how vacuum power is used, were credited the full marks available.

Exemplar 4


A vacuum could be used to transport items around a factory such as componants for a product. The suction would move the parts along ~~t~~ a tube to their destination [3]

In exemplar 4, the candidate has given a good example of vacuum being used in manufacturing, and has fully described what vacuum is being used for.

Question 3(c)

(c) Give **two** benefits of using vacuum power in food manufacturing.

1 ....

2 ....
[2]

This question part was also reasonably well answered with most candidates achieving at least one mark. Responses tended to relate more to the description required for part 3(b), however credit was given wherever possible for answers that demonstrated understanding. It was recognised by examiners that the two question parts could elicit very similar responses.

Question 3(d)

(d) Name **one** other power source used in engineering.

.... **[1]**

It was anticipated that this question part would enable candidates to name the power sources stated in Learning Outcome 4 of the specification without difficulty. Although most candidates were able to achieve this, many candidates deviated from this by giving answers of forms of energy (i.e. heat) or naming components related to a power source or output, such as "pump", "generator", "battery".

Question 4(a)(i)

4 Fig. 4 shows a gear train.

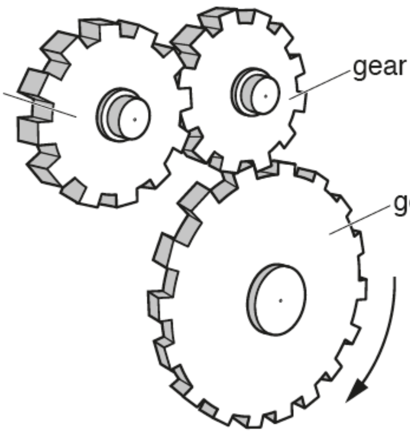


Fig. 4

(a) **(i)** State which gear, **A**, **B** or **C**, in Fig. 4 is the idler gear.

.... **[1]**

This part question was well answered by the majority of candidates.

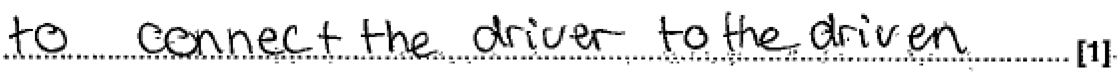
Question 4(a)(ii)

(ii) State the purpose of the idler gear used in this example.

.... **[1]**

Although many candidates gave correct answers, many responses were vague and did not always show that the candidate has a clear understanding.

Exemplar 5



This candidate's answer was not credited the mark because the answer given does not clearly show understanding that the purpose of the idler gear is to keep gears A & C rotating in the same direction.

Question 4(a)(iii)

(iii) Calculate the velocity ratio of the gear train in Fig. 4.

....

....

.... **[2]**

This question required candidates to calculate the gear ratio and present their answer as a ratio. The majority of candidates incorrectly completed the calculation using the Diver/ Driven instead of the other way around. Where candidates correctly performed the calculation, most candidates did not achieve the second mark for presenting the answer as a ratio.

Question 4(b)(i)

(b) **(i)** State what is meant by the term 'compound gear'.

.... **[1]**

Question part 4(b)(i) was reasonably well answered by most candidates although some unclear answers were given, which did not adequately demonstrate understanding of the term.

Exemplar 6

Two gears together. **[1]**

This candidate's answer was too vague to be credited the mark because the answer could mean a variety of gear arrangements. Candidates must make their answers precise and not open to interpretation, particularly on single mark questions.

Question 4(b)(ii)

(ii) Give **one** application that could use compound gears.

.... **[1]**

For part 4(b)(ii) nearly all candidates gave an appropriate example of an application that could use compound gears.

Question 4(c)(i)

(c) Fig. 5 shows a gearbox for a toy car driven by a direct current (DC) motor using a worm gear.

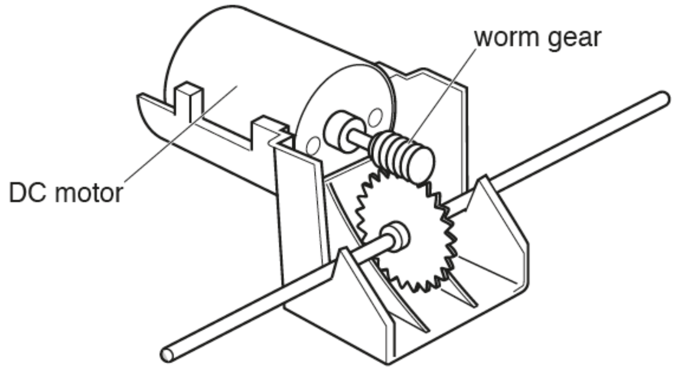


Fig. 5

(i) Give **one** advantage of using this arrangement to make the toy car move.

.... **[1]**

Fewer than expected candidates gave correct answers to this part, with the majority of correct answers, being limited to stating that the arrangement was compact / space saving.

Question 4(c)(ii)

(ii) State the energy conversion that takes place to make the toy car move.

.... to .... **[2]**

This question was very well answered with the vast majority of candidates achieving full marks.

Question 4(c)(iii)

(iii) State how the direction of the motor can be reversed.

.... **[1]**

AfL: Very few candidates were able to answer this part correctly. Previous Principal Examiner reports for R101 have highlighted that candidates' knowledge and understanding of motors is underdeveloped. This continued to be evident in the candidates' responses for this paper.

Question 5(a)(i)

5 Fig. 6 shows a pneumatic door system used on a bus.

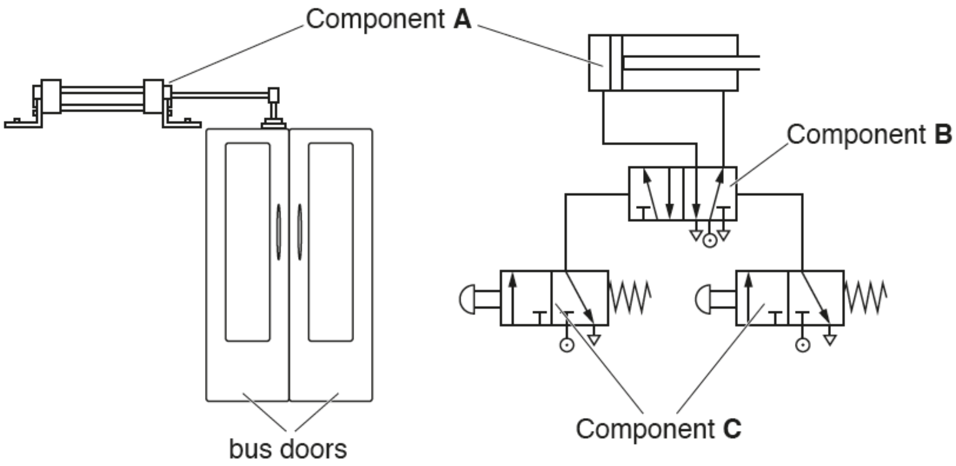


Fig. 6

(a) **(i)** Name components **A** and **C**.

A ....

C ....

[2]

Most candidates were able to correctly name the double acting cylinder and there were few variations given in answering this part. However, fewer candidates were able correctly name the 3/2 valve. Examiners were instructed to only accept 3/2 valve and no other incorrect variations i.e. "4/2 valve" "2/3" etc. Many candidates also added "push button return spring" or similar to the "3/2" demonstrating their knowledge, although this was not necessary to gain the available marks.

Question 5(a)(ii)

(ii) Explain how components **B** and **C** are used to control the operation of the door.

....

....

....

....

.... **[4]**

Few candidates were able to be credited with more than 2 marks for this part. Some candidates described operation requiring both 3/2 valves being pressed at the same time, such as in an AND circuit. Many candidates omitted to mention the purpose of component B in their answers, and very few candidates explained the 5/2 valve being used to hold the double acting cylinder in position.

Exemplar 7

By Pushng c It is going to put Presure into the Double acting Sylinder Pushing It open and that will not move back untill 3/2 valve is pushed again Pushing the cylinder back to original Position **[4]**

Explain why component **A** does not use a return spring.

In this exemplar, the candidate has explained the correct operation of component C, the 3/2 valve, but has not included the role and operation of component B to be able to be credited further marks.

Question 5(a)(iii)

(iii) Explain why component **A** does not use a return spring.

....

....

.... **[2]**

Correct answers for this part tended to be by higher achieving candidates, who were able to briefly explain the operation of the double acting cylinder. Simpler explanations of impact of using a single acting cylinder, or the need to hold the 3/2 valve open, or that air is used to return the cylinder, were also accepted.

Exemplar 8

it is dual acting Meaning the two buttons controll whether it is extended or retracted. [2]

In exemplar 8, the candidate has adequately explained that the double acting cylinder is controlled to extend and retract.

Question 5(a)(iv)

(iv) Give the meaning of the term 'main air'.

....

.... **[1]**

Very few candidates correctly gave the meaning of main air in part 5(a)(iv). The answers given were often vague and as a 1 mark question, examiners were unable to award the mark if they answer was ambiguous.

Exemplar 9

this is the main air used in the System to opperate the System. [1]

This candidate's answer is too vague and does not reference either the main air as coming from the source i.e. reservoir, or supply and therefore was not credited the mark.

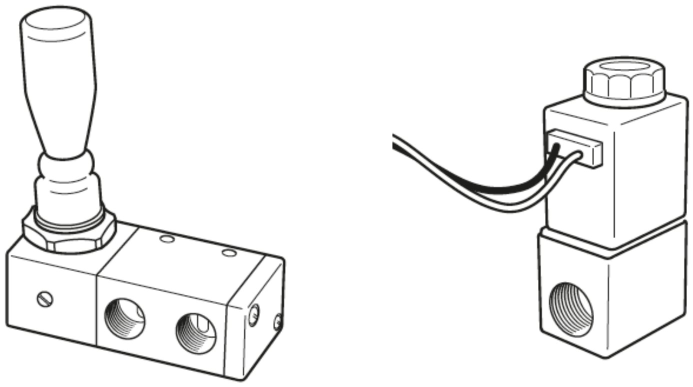
Question 5(a)(v)

(v) Add **one** label **to** the pneumatic circuit in Fig. 6 to show **one** of the main air ports. **[1]**

Question part 5(a)(v) is the third part question within this examination paper which a much greater number of 'no attempts' than would be expected. Candidates were required to label the one of the main air ports on the pneumatic system diagram in Fig. 6. Candidates could have labelled any one of the three main air ports shown in the diagram to achieve the mark. Of those that did answer, the majority of answers across the ability range were incorrect.

Question 6(a)(i)

6 Fig. 7 shows two components used to control flow in fluid power systems.



Component **A** Component **B**

Fig. 7

(a) (i) State the method of operation each of the components uses to control flow.

Component **A** ....

Component **B** ....
[2]

Overall, this part received a variable response from candidates. Few candidates achieved full marks. Candidates often attempted to name the components, or described the purpose of the component, rather than stating the method of operation. Candidates should take more care in reading the instructions, rather than looking at the images and assuming what the question requires of them.

Exemplar 10

Component **A** 3/2 valve allows air to go in one way and out the other side ~~cyclic valve~~

Component **B** Solenoid valve uses an electro magnet.

The exemplar above demonstrates that the candidate has either not read or interpreted the question adequately, and has instead named the component and gone on to describe the purpose of the component.

Question 6(a)(ii)

(ii) Give **one** hydraulic application that could use component **A**.

.... **[1]**

Nearly all candidates gave correct answers to this part.

Question 6(a)(iii)

(iii) Name **one** component that could be used to control component **B**.

.... **[1]**

AfL: This part question was poorly answered by most candidates with very few achieving a mark. The question is based on the content within Learning Outcome 3 of the specification for R101; operation, application and symbols of simple fluid power system components i.e. control. It was expected that candidates would answer with one of the four examples within this part of the specification; i.e. push (switch) roller tip, or lever switch. Benefit of doubt was given where candidates answered with "Button" but not with a further simplified answer of "switch".

Question 6(b)*

(b)* Discuss the benefits of using electrical systems to control pneumatic applications in engineering.

....

....

....

.... **[6]**

Some candidates strayed from the question which is based on the benefits of electrical systems to control pneumatic applications, and focused their answers on either the benefits of electrical compared to pneumatics. Other candidates were able to describe with industry examples of how electrical systems could be used to control pneumatics, to achieve a Level 2 response. There were relatively few responses that achieved a Level 3 mark, due to the absence of technical / specialist terms and/or the lack of structure within the response.

Exemplar 11

Electrical systems are more useful to our advanced technology and most things are operated or used by electricity, electricdl systems are used more in engineering because it is a faster and more advanced than Pneumatics. Pneumaties is good but slow compared to electical, once electrical systems are set up they can be left and not need to be bothered with but pneumatics has to be controlled everytime it is in use

Electrical systems are set up easily and only take a certain amount of components which is understandible to some.

Pneumatics is set up in many different ways and is confusing to some. **[6]**

Exemplar 12

~~Ans~~ An example where electrical is used to control pneumatic operations is when a product is weighed on a contruction line and is under or over the weight it needs to be this electrical scales trigger a sensor and a pneumatic piston pushes the product out the line. The use in this case is beneficial as both electrical used and pneumatic are to ~~me~~ control a pneumatic system and is quick so there is no time delay and the process can be quick. Also it could be used an electric system could be used to lift a product it can be done very quick and because it is with an electrical system the system can be used to accuratly time when to lift and drop the product they are also good ~~because~~ for safety reasons for doors etc so the electrical system will stop the doors from opening (using pneumatic system) if the train / bus is still moving a sensor is used and an electric system is then sent to switch on the pneumatic valve to open a cylinder. Another benefit is that the use of electrical systems is good because if the product / line etc is changed the new programme and times can be put into the computer and easily changed to the new product such as **[6]** the amount of air allowed through to the unidirectional flow control valve. However the initial cost of these systems are very expensive.

In the first exemplar shown, in contrast to the question, the candidate has presented a comparison between electrical and pneumatic systems resulting in marks being credited as a Level 1 response.

The second exemplar shows a Level 3 response where the candidate has given several examples of applications incorporating electrical control of pneumatics, with some detail of using sensors and signals.

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