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Cambridge **NATIONALS LEVEL 1/2**

Cambridge NATIONALS

ENGINEERING PRINCIPLES

Combined feedback on the June 2017 exam paper (including selected exemplar candidate answers and commentary)

Unit R101 – Engineering principles

Version 1

ocr.org.uk/engineering

CONTENTS

INTRODUCTION

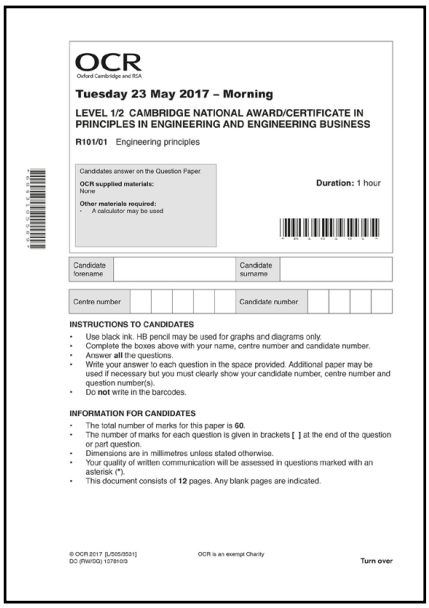
This resource brings together the questions from the June 2017 examined unit (Unit R101), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

We have also included exemplar candidate answers with commentary for Questions 1, 3, 5.

The marking guidance and the examiner's comments are taken from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:

https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250



OCR
Oxford Cambridge and RSA

Tuesday 23 May 2017 – Morning

LEVEL 1/2 CAMBRIDGE NATIONAL AWARD/CERTIFICATE IN PRINCIPLES IN ENGINEERING AND ENGINEERING BUSINESS

R101/01 Engineering principles

Candidates answer on the Question Paper.

OCR supplied materials: None

Other materials required: A calculator may be used

Duration: 1 hour

Candidate forename | Candidate surname

Centre number | Candidate number

INSTRUCTIONS TO CANDIDATES

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The total number of marks for this paper is **60**.
- The number of marks for each question is given in brackets **[ ]** at the end of the question or part question.
- Dimensions are in millimetres unless stated otherwise.
- Your quality of written communication will be assessed in questions marked with an asterisk (*).
- This document consists of **12** pages. Any blank pages are indicated.

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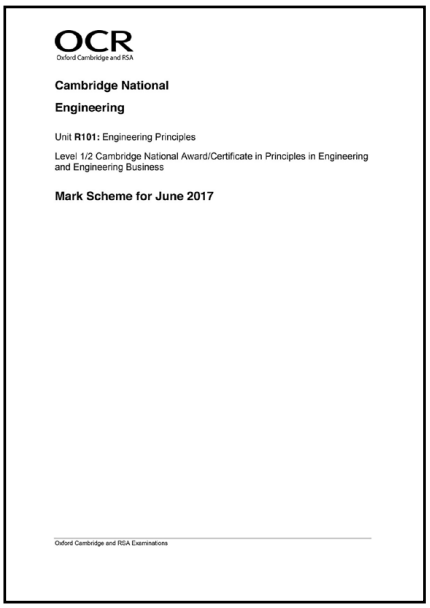

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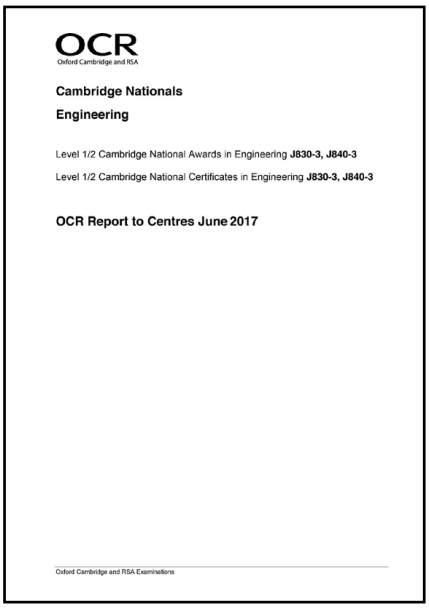
Engineering

Unit **R101:** Engineering Principles

Level 1/2 Cambridge National Award/Certificate in Principles in Engineering and Engineering Business

Mark Scheme for June 2017

Oxford Cambridge and RSA Examinations



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Cambridge Nationals
Engineering

Level 1/2 Cambridge National Awards in Engineering **J830-3, J840-3**

Level 1/2 Cambridge National Certificates in Engineering **J830-3, J840-3**

OCR Report to Centres June 2017

Oxford Cambridge and RSA Examinations

GENERAL EXAMINER COMMENTS ON THE PAPER

Many candidates attempted all of the questions on the paper although there were exceptions where some candidates had only attempted a few questions within the entire paper.

Questions Q4(d)(i), 6(a) and 6(b) had a higher incidence of omitting to answer (No Response) than anticipated. For question 4(d)(i), candidates were required to annotate the diagram but may have missed the instruction to do so. Generally, throughout the exam paper, there was some evidence that candidates had not read questions carefully enough before answering. It is most important that candidates take the time to read through the question paper before attempting to answer questions and ensure that they have responded to all questions including annotating diagrams where required.

Knowledge of mechanical principles appeared to have improved in some aspects. Candidates demonstrated the ability to perform mathematical calculations reasonably well in two out of the three questions requiring calculation.

Knowledge and understanding of pneumatic systems, hydraulic systems and components, forms a significant proportion of the specification for R101/01. Candidates demonstrated only a limited and basic knowledge of pneumatic and hydraulic system applications. Responses were often lacking in technical terminology. Overall, candidates would benefit from further study of the application and design of mechanical, electrical and fluid power systems. Industrial visits or similar activities could help improve learners' understanding, and support them in being able to competently answer questions such as 1(a)(iii), 6(a), and 6(b).

Resources which might help address the examiner comments:

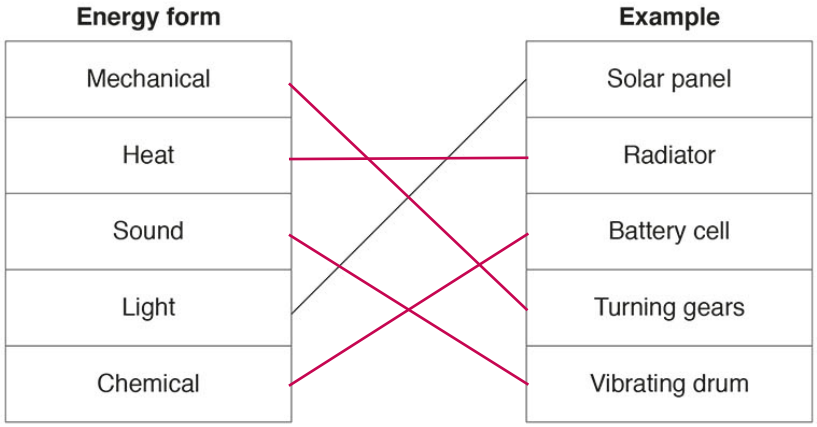
From the link below, you'll find 'The OCR guide to examinations' (along with many other skills guides)
http://www.ocr.org.uk/i-want-to/skills-guides/

Question 1

Answer **all** the questions.

1 (a) Energy can be produced in many different forms.

(i) Draw lines to link the energy form to the correct example.
One has been done for you.



[4]

(ii) Give **one** application of spur gears in use.

One mark from e.g.:
- Gearbox (1)
- Bicycle (1)
- Clock (1)
- Wind-up toy (1)
- Lathe (1)

..... **[1]**

(iii) Describe **one** example of how electrical energy is used to perform a mechanical task.

Up to **two** marks for a description of an appropriate example e.g.:
- An electric motor (1) is used through a gearbox to turn a chuck (1)
- Electrical energy power the lathe (1) to be able to turn the material (1)
- A current passed through the coil of a relay (1) closes switch contacts. (1)

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

(b) (i) Describe how energy conversion is achieved using a wind up torch light.

Up to two marks for a description e.g.:
- Mechanical/kinetic power (1) from turning handle will generate electricity (1)
- Mechanical power (1) used to turn a handle creates an electric current (1) to light the torch.
- Kinetic energy (1) of winding the torch creates electrical energy (1).

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

(ii) A pendulum at the highest point of its swing is an example of potential energy.
Give **one** other example of potential energy.

One mark from e.g.:
- A compressed spring (1)
- A stretched elastic band (1)
- Pendulum about to be released (1)
- A rollercoaster at its highest point. (1)

..... **[1]**

Mark Scheme Guidance

Question 1(a)(i):

Do **not** award line drawn from 'Light' to 'Solar panel' as that is given in the question.

Question 1(a)(ii):

Accept any appropriate examples.

Question 1(a)(iii):

Accept appropriate application examples e.g.:

Lathe, drill etc.

1 mark for the example, 1 mark for description.

Question 1(b)(i):

Accept appropriate variations.

Question 1(b)(ii):

Accept other appropriate examples. Award a mark for a good example.

Examiner comments

Question 1(a)(i) and (ii) – Most candidates achieved full marks for part (a)(i) for correctly matching the terms. Candidates often gave vague answers to part 1(a)(ii) rather than specific applications for the spur gear.

Question 1(a)(iii) – Lower ability candidates found difficulty in providing an appropriate mechanical application.

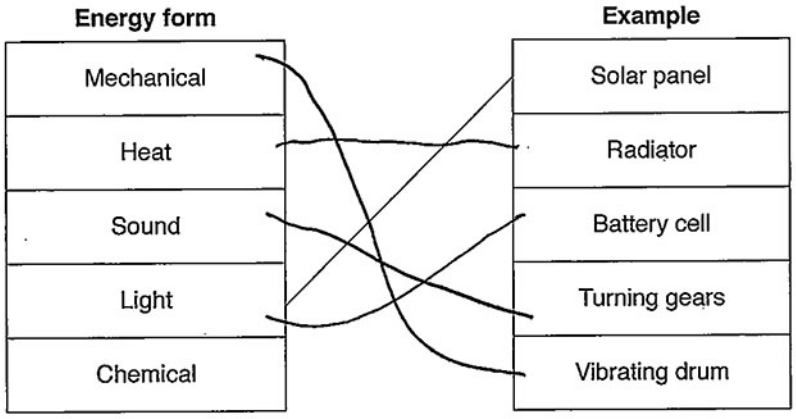
Question 1(b)(i) – Some candidates used technical terminology such as "kinetic" (although not necessarily required for this question) to provide a correct description for the wind-up torch.

Question 1(b)(ii) – Fewer candidates gave correct examples of potential energy and often gave examples of gravitational potential energy.

Exemplar candidate work
Questions 1(a)(i), (ii), (iii) – Low level answers

1 (a) Energy can be produced in many different forms.

(i) Draw lines to link the energy form to the correct example.
One has been done for you.



[4]

(ii) Give **one** application of spur gears in use.

It can be use in motors [1]

(iii) Describe **one** example of how electrical energy is used to perform a mechanical task.

The Virating dumy needs ~~and~~ an electrical button to start the Vibrating ~~motion~~ motion. [2]

Commentary

Question 1(a)(i) – Candidates were required to draw lines to link the energy form to the correct example given. Most candidates achieved full marks for part (a)(i) for correctly matching the terms. Candidates achieving low level marks for this part would have only linked one or two of the energy forms to the correct example. In the example shown, the candidate has correctly linked one energy form to the example. Candidates could improve their answers to a medium level answer by carefully selecting the correct energy form and linking this to an example they know to be correct, and repeating this approach to eliminate possible incorrect matches.

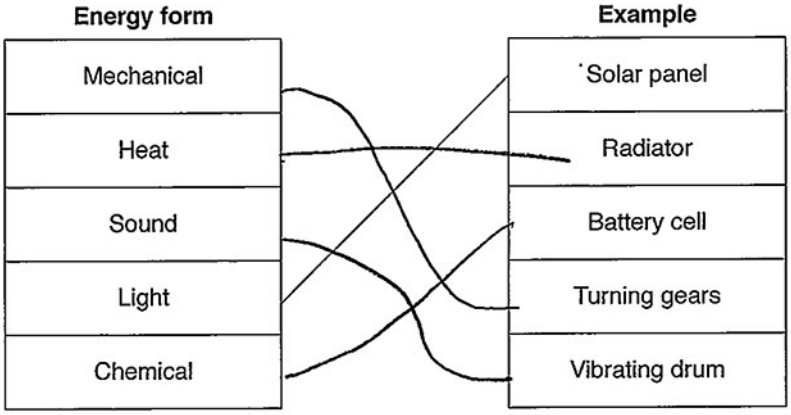
Question 1(a)(ii) – Candidates often gave vague answers to part 1(a)(ii) rather than specific applications for the spur gear. Candidates achieving a low level answer for this part may have given incorrect examples of an application where spur gears are used, such as in the example shown. Candidates could improve their level of answer by giving an answer more aligned to examples that they will have been taught or handled in a workshop, such as a gearbox.

Question 1(a)(iii) – Candidates were asked to describe how electrical energy is used to perform a mechanical task. Candidates giving low level answers will have, in some case named an electrical component such as a switch or a motor. In the example shown, the candidate partly describes a system using an electric circuit component, but does not give details of how the electrical energy is transformed into a mechanical task. Candidates could improve their response by completing a description of the how the mechanical motion is achieved. For example, current applied to a solenoid, which pushes a lever outward.

Exemplar candidate work
Questions 1(a)(i), (ii), (iii) – High level answers

1 (a) Energy can be produced in many different forms.

(i) Draw lines to link the energy form to the correct example.
One has been done for you.



[4]

(ii) Give **one** application of spur gears in use.

Mechanical Clock ..... **[1]**

(iii) Describe **one** example of how electrical energy is used to perform a mechanical task.

Electrical energy is used to perform a startup on a car the battery sends electricity which power up the motor then helps the engine to get going. ..... **[2]**

Commentary

Question 1(a)(i) – Candidates achieving high level answers have carefully and methodically linked the correct energy form with the correct example. These candidates will have drawn their link lines neatly and clearly. Where a mistake has been initially made, candidates will have corrected this so that the answer is presented clearly leaving no ambiguity of their final answer. In the example shown, the candidate has correctly linked all four of the energy forms each with the correct example.

Question 1(a)(ii) – Candidates achieving a high level answers for this part have given answers that are obvious examples of an application where spur gears are used, such as in a vehicle gearbox, or as in the example shown, a mechanical clock.

Question 1(a)(iii) – Candidates giving high level answers have provided detailed answers such as electrical switch contacts which are used to provide current to a motor, which turns. Candidates may have used technical terms in their description to describe the mechanical action. In the example shown, the candidate has described an example of a car, and the source of the electrical energy (a car battery) which is used to power a motor.

Exemplar candidate work
Questions 1(b)(i), (ii) – Low level answers

(b) (i) Describe how energy conversion is achieved using a wind up torch light.

The chemical energy from the battery which turns into electrical then [2]

(ii) A pendulum at the highest point of its swing is an example of potential energy.
Give **one** other example of potential energy.

A round about on a park. [1]

Commentary

Question 1(b)(i) Candidates were asked to describe how energy conversion is achieved using a wind up torch light. Answers were expected to contain a description of mechanical or kinetic power used to generate an electrical current. Candidates giving low level answers may have incorrectly described the operation of a battery operated touch, as shown in this example. Candidates could improve their answers by first determining the energy conversion that needs to take place, and secondly describing the means of how the conversion will take place.

Question 1(b)(ii) Candidates giving low level answers will have often given incorrect answers, unrelated to potential energy such as the example shown.

Exemplar candidate work
Questions 1(b)(i), (ii) – High level answers

(b) (i) Describe how energy conversion is achieved using a wind up torch light.

The kinetic energy from the torch being wounded is changed into electrical which goes around a circuit and *Powers up the torch. [2]

(ii) A pendulum at the highest point of its swing is an example of potential energy.
Give **one** other example of potential energy.

like a stretched elastic band [1]

Commentary

Question 1(b)(i) Candidates who gave high level answers provided detail about the how the mechanical action was produced and how the energy conversion was achieved. In the example shown, the candidate has included technical terms such as "kinetic" in their answer.

Question 1(b)(ii) Candidate who gave high level answers were able to give a correct example of potential energy, such as the example shown.

Question 2(a)

2 Fig. 1 shows a fishing rod used as a simple lever.

Correctly labelled:

Load (1)

Effort (1)

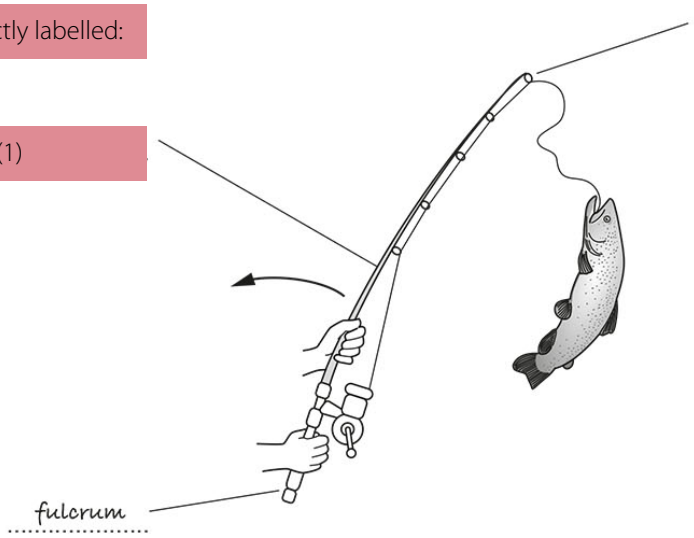


Fig. 1

(a) (i) Complete the labels on Fig. 1 with the correct parts of the lever. One has been done for you. **[2]**

(ii) State what class of lever is represented by the fishing rod.

Class 3 lever (1) **[1]**

(iii) Explain how the use of the fishing rod as a lever is different from the use of a pair of scissors.

Up to three marks for an explanation e.g.:
The fishing rod is a class 3 lever/which uses the effort before or in front of the load/ with the fulcrum acting as a lever (1). The scissors are a pair of class 1 levers (1) with the pivot in between the load and the effort/force (1)
Scissors have two levers (1)

[3]

Question 2(b)

(b) Fig. 2 shows a charging device for handheld electrical equipment.

Fig. 2

(i) State **two** ways that the input voltage differs from the output.

1 .....

....

2 .....

.....

[2]

One mark for each way stated up to a maximum of two marks.
- The input uses AC/high voltage (1)
- The output is DC/low voltage (1)
- A transformer steps down the input (1)

(ii) Give **two** benefits of using rechargeable DC electrical devices.

1 .....

....

2 .....

.....

[2]

One mark for each benefit given up to a maximum of two marks:
- Portable (1)
- Low voltage making them safe (1)
- Do not need to keep replacing batteries (1)

Mark Scheme Guidance

Question 2(b)(ii):

No marks for 'they are rechargeable' as this is given in the question.

Examiner comments

Question 2(a)(i) and (ii) – Candidates were required to label the diagram with the correct terms for the lever (in this case a fishing rod). The majority of candidates attempted the question but many candidates used incorrect terms such as "force" and "weight".

For part (ii), relatively fewer candidates correctly gave the correct class of lever.

Question 2(a)(iii) – Candidates across the ability range were able to achieve marks for this part, with many at least correctly recognising the difference in location of the fulcrum.

Question 2(b)(i) and (ii) – Candidates across the ability ranges answered these parts less well than expected, demonstrating little recognition or knowledge of AC to DC conversion.

Question 3(a)

3 (a) An engine-driven pulley is used to drive a generator.

The driver pulley has a diameter of 180 mm and the driven pulley has a diameter of 90 mm.

(i) Calculate the velocity ratio of the pulleys.

Velocity ratio = driver/driven (1)
180/90 = 2:1 or 2 (2)

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

(ii) State the speed of the generator when the engine is turning at 1000 revolutions per minute.

2000* (1)

..... **[1]**

(iii) Give **two** advantages of using a pulley and belt system.

1 .....

2 .....

One mark for each advantage up to a maximum of two marks from:
- Belts and pulleys do not require lubricating like gears do (1)
- Belts can be adjusted to assist with changing the belt. (1)
- Quiet operation (1)
- Some belts can slip if there is a seizure/collapsed bearing (1)
- Belts can be maintained /Easily changed when worn (1)
- Pulleys reduce the effort needed (1)
- Requires less effort to lift a load (1)

[2]

(iv) A hydraulic pump is also driven by the engine.
Give **one** application for the hydraulic pump.

One mark from:
- Power steering pump (1)
- Lift pump (1)
- Power take off (1)
- Fork lift truck (1)
- Digger rams (1)

[1]

(v) Pulley systems are one way of driving ancillary equipment such as generators and pumps.
Give **one** other method that could be used.

One mark from:
- Gears (1)
- Shaft drive (1)

[1]

Question 3(b)

(b) Fig. 3 shows an engine-driven generator.

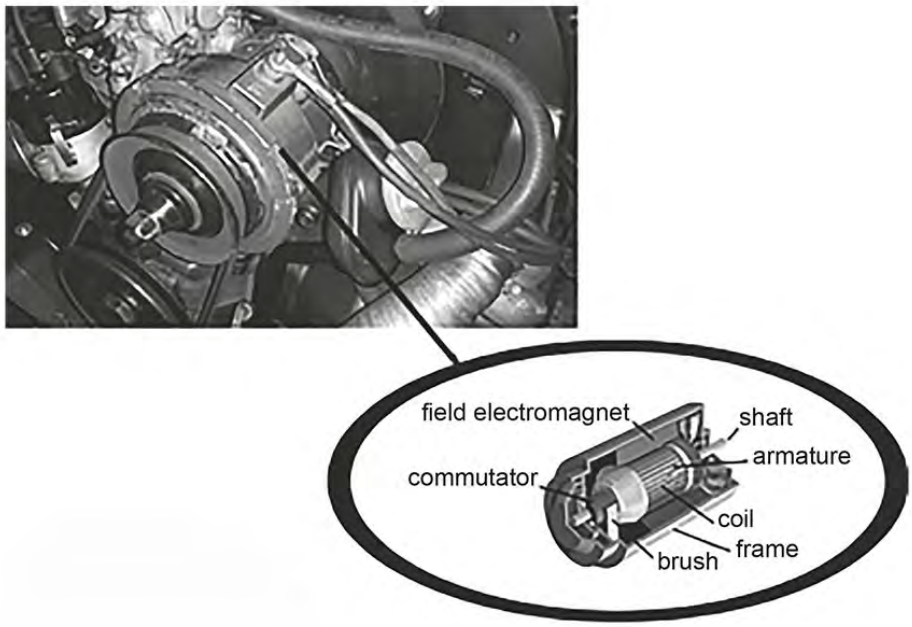


Fig. 3

Explain how the generator in Fig. 3 is used to produce electrical energy.

Up to three marks for an explanation.
Marking points could include e.g.:

- The engine recreates rotation through the pulley to turn the generator (1).
- The rotating armature coil cuts the magnetic lines of force (1) produced by the field coils (1)
- Current is induced into the armature (1)
- The commutator converts the AC current to a DC current (1).

..... [3]

Mark Scheme Guidance

Question 3(a)(i):

1 mark if correct formula seen but incorrect final answer given.

Award 2 marks if correct answer seen.

Question 3(a)(ii):

Allow 500 for ECF

Allow ecf for VR from (i):

Output speed = input speed × velocity ratio

Output speed = 1000 × 2* = 2000 rpm

Question 3(a)(iv):

Accept responses where a valid application of a hydraulic pump is given e.g. digger ram.

Question 3(b):

Accept a simple explanation of a coil passing through a magnetic field for 1 mark.

Examiner comments

Question 3(a)(i) and (ii) – Candidates performed well on this calculation question with the majority of candidates achieving the 2 available marks. However, some candidates went on to incorrectly present the ratio. For part (ii) error carried forward was allowed when possible, where candidates incorrectly stated the ratio in part (i).

Question 3(a)(iii) – Although this question was focused on pulley and drive belt applications, some candidates interpreted the question in terms of mechanical advantage applications. The mark scheme therefore rewarded correct examples relating to mechanical advantages such as "easier to lift the load".

Question 3(a)(iv) – Candidates generally demonstrated a lack of knowledge and awareness of hydraulic pump applications.

Question 3(b) – Candidates struggled with communicating an explanation of how the generator works. Marks were awarded where candidates were able to give some explanation of the armature rotating between the coils to produce a current.

Exemplar candidate work
Questions 3(a)(i), (ii), (iii), (iv), (v) – Low level answers

3 (a) An engine-driven pulley is used to drive a generator.

The driver pulley has a diameter of 180 mm and the driven pulley has a diameter of 90 mm.

(i) Calculate the velocity ratio of the pulleys.

180 ÷ 90 = 2

1 : 2

[2]

(ii) State the speed of the generator when the engine is turning at 1000 revolutions per minute.

2 x 1000 = 2000

1 x 1000 = 1000 = 3000 rpm [1]

(iii) Give **two** advantages of using a pulley and belt system.

1 It requires less effort to lift a load

2 Depending on the gears, it will become faster to use.

[2]

(iv) A hydraulic pump is also driven by the engine.
Give **one** application for the hydraulic pump.

On crane (truck version) [1]

(v) Pulley systems are one way of driving ancillary equipment such as generators and pumps.
Give **one** other method that could be used.

Pneumatics [1]

Commentary

Question 3(a)(i) – Candidates achieving low level answers have in many cases applied the formula incorrectly as driven/driver instead of the correct driver/driven. This results in the calculation giving an incorrect answer. Other candidates have applied the formula correctly to get the correct answer, but then have presented the ratio incorrectly, which invalidates the calculation, as in the example shown. This candidate could have improved their answer by stopping at the point where they completed the calculation. The mark scheme allowed for candidates to either give the ratio, or simply the numerical value for the calculation i.e. 2.

Question 3(a)(ii) – Candidates achieving low level answers will have incorrectly applied the formula from part 3(a)(i) and therefore given an incorrect answer as shown. Candidates were not required to give the units in their answer to gain the mark.

Question 3(a)(iii) – Candidates will have given one or more incorrect statements which are unrelated to the advantages of pulley and belt systems, as shown. The first answer, in the example shown, is actually related to mechanical advantage, rather than the intended application of a drive system using pulleys and belts. However the mark was awarded as it was deemed to be an alternative interpretation of the question. In this context, the answer was worthy of the mark.

Question 3(a)(iv) – Candidates were required to give one application of a hydraulic pump. Some candidates gave very general answers that were not specific enough to demonstrate knowledge of hydraulic systems, in order to be awarded credit.

Question 3(a)(v) – Candidates may not have either read the question properly and given an incorrect answer, or just as in this example, some candidates provided answers which were unrelated to mechanical applications.

Exemplar candidate work
Questions 3(a)(i), (ii), (iii), (iv), (v) – High level answers

3 (a) An engine-driven pulley is used to drive a generator.

The driver pulley has a diameter of 180 mm and the driven pulley has a diameter of 90 mm.

(i) Calculate the velocity ratio of the pulleys.

180mm:90mm =2:1

[2]

(ii) State the speed of the generator when the engine is turning at 1000 revolutions per minute.

2:1 2X1000=2000

2000

[1]

(iii) Give **two** advantages of using a pulley and belt system.

1 If in need of maintainence, it can be easily repaired

2 The pulley and belt can be altered to fit the users need(s).

[2]

(v) Pulley systems are one way of driving ancillary equipment such as generators and pumps.
Give **one** other method that could be used.

Gears [1]

Commentary

Question 3(a)(i) – Candidates achieving high level answers have shown their working out and presented the correct answer as either a whole number or a ratio.

Question 3(a)(ii) – Candidates achieving high level answers have correctly stated the speed of the generator using the ratio from their answer to question 3(a)(i).

Question 3(a)(iii) – Candidates will have given two appropriate answers clearly stating advantages of using pulley and belt drive systems, such as ease of maintenance or adjustment.

Question 3(a)(iv) – The answer shown is a hydraulic application which would use a hydraulic pump to create pressure to operate the system. Marks were awarded for feasible applications.

3(a)(v) – Candidates achieving a mark were able to give a correct method of driving ancillary equipment, as per the mark scheme.

Exemplar candidate work
Question 3(b) – Low level answer

(b) Fig. 3 shows an engine-driven generator.

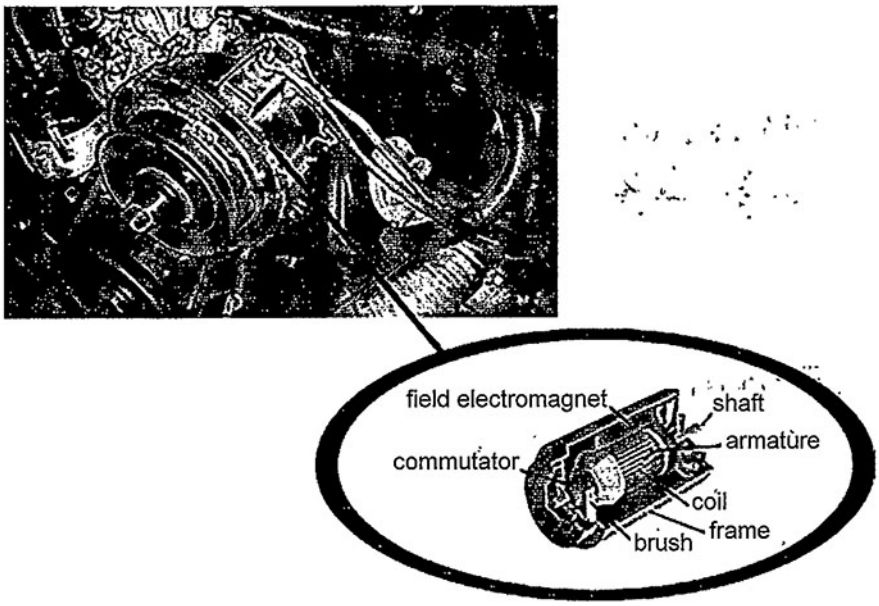


Fig. 3

Explain how the generator in Fig. 3 is used to produce electrical energy.

When the motor is being spinned the magnetic field is being created since the coil is providing an insulator to create electricity that powers the generator for the engine driver. [3]

Commentary

Question 3(b) Candidates struggled with communicating an explanation of how the generator works. Marks were awarded where candidates were able to give some explanation of the armature rotating between the coils to produce a current. In the example shown, credit was awarded for references to the spinning creating a magnetic field. The remainder of the response did not show an understanding of generator principles. The candidate could have improved their answer to a medium level answer by stating that the generator is turned or driven by the engine.

Exemplar candidate work
Question 3(b) – High level answer

(b) Fig. 3 shows an engine-driven generator.

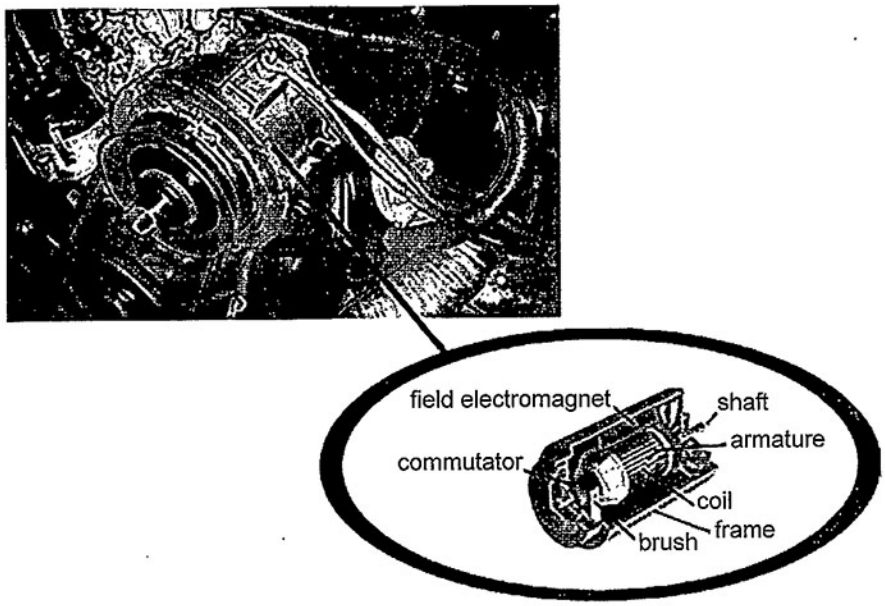


Fig. 3

Explain how the generator in Fig. 3 is used to produce electrical energy.

When the engine is on the coil is turned by the shaft which cuts through the electromagnetic field produced by the electromagnet this induces a current in the coil producing electricity

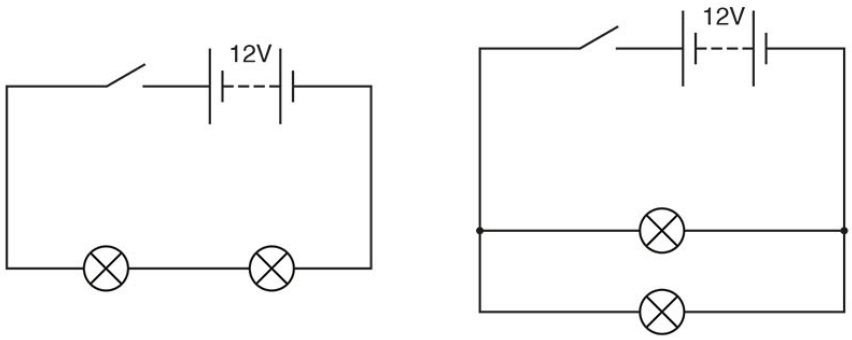
[3]

Commentary

Question 3(b) Candidates achieving high level answers show understanding of the generator principles, correctly using technical terms in a methodical order to describe the generator operation.

Questions 4(a), (b) and (c)

4 **(a)** Fig. 4 shows two lighting circuits.



circuit **A** circuit **B**

Fig. 4

(i) State the arrangement of circuit **A**.

Series (1) **[1]**

(ii) Suggest why the arrangement in circuit **B** is usually used for lighting circuits.

If one lamp fails the other will keep working (1)

..... **[1]**

(iii) State the name of unit that is used to give the power rating of the lamps.

Watt or Watts (1) **[1]**

(b) Complete the following statement using the correct terms from the list below.

series **resistor** **ammeter** **parallel**

To measure current, the ..... Ammeter (1) ..... is placed in ..... Series (1) ..... with the component, while a voltmeter is placed in ..... Parallel (1) ..... with the component to measure the voltage. **[3]**

(c) Each lamp filament in circuit **A** has a resistance of 2.6 Ω.
Calculate the total current flowing with the switch closed.

2.6Ω × 2 = 5.2 (1) or .....
12/5.2 (1)
= 2.3 (A) (1) .....

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

Question 4(d)

(d) (i) Fig. 5 shows a multimeter.
Draw an arrow to show the dial position to measure the potential difference of the circuit.

One mark for correct arrow drawn on Fig. 5:
Arrow shows the multimeter set to (V) DC Volts (1)

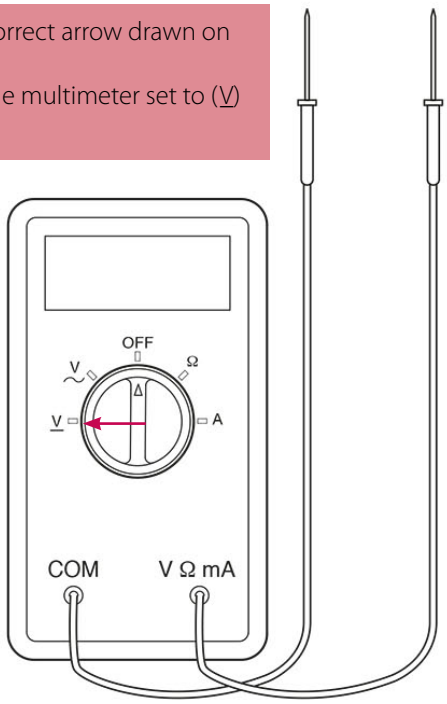


Fig. 5 **[1]**

(ii) When measuring the potential difference, state the effect on the meter reading if the polarity of the probes is reversed.

The reading would be a negative reading e.g. -12v .....

..... **[1]**

Mark Scheme Guidance

Question 4(b):

Correct order only:

Question 4(c):

Award 2 marks for a correct answer with no units.

Only award full marks for the correct answer.

Examiner comments

Question 4(a) – Candidates generally performed well for parts 4(a)(i) and (ii), but relatively fewer candidates correctly gave the correct unit for power.

Question 4(b) – The question was very well answered by candidates of all abilities with most candidates achieving the full 3 marks available.

Question 4(c) – Candidates at the middle and higher ability range recognised the requirement to multiply the resistance of both lamps to give the correct resistance value. Some candidates did not use this sum to go on to using Ohm's law to calculate the current, and therefore only achieved 1 of the 2 available marks.

Question 4(d)(i) and (ii) – In part (i) candidates were required to annotate the diagram of the multimeter to indicate the correct setting. It appears that candidates may not have read the instruction at the top of the page and omitted to annotate the diagram as required. Some candidates incorrectly selected the AC symbol instead of the DC. Despite this, many candidates gave the correct answer for part (ii).

Question 5(a)

5 Fig. 6 shows a workshop compressor.

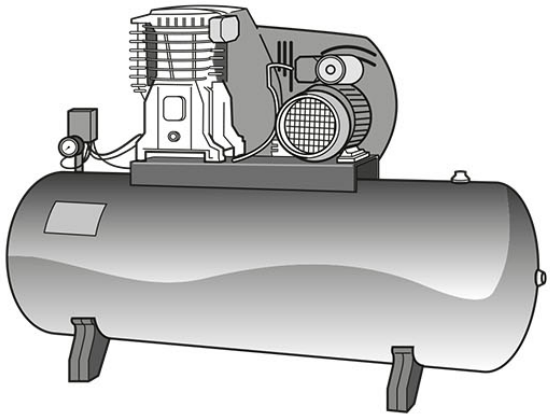


Fig. 6

(a) (i) Explain how the compressor is used to produce and store a source of power for a pneumatic system.

Up to three marks for an explanation. Marking points could include e.g.:
- An electrical supply is used to provide power to the motor (1) A motor-driven mechanical piston engine draws in air and compresses the air (1)
- Compressor pumps air into the reservoir (1)
- The motor stops when the pressure reaches a pre-set value (1) and starts again when the pressure falls below this. (1)
- Compressed air is stored in the receiver (1) and delivered to the pneumatic system when required (1)
- Pressure gauge is used to monitor pressure (1)
- Pressure relief valve releases excess pressure (1)

[3]

(ii) State how the pressure could be measured in a pneumatic or hydraulic system.

Using a pressure gauge (1)

[1]

(iii) Give **one** reason why, when measured, the pressure in a pneumatic or hydraulic system may be lower than expected.

One mark from:
- There is a leak in the system (1)
- The pre-set pressure has been regulated down. (1)
- The compressor is off (1)
- There is air in the system (hydraulic) (1)

[1]

Question 5(b)

(b) Fig. 7 shows a hydraulic jack.

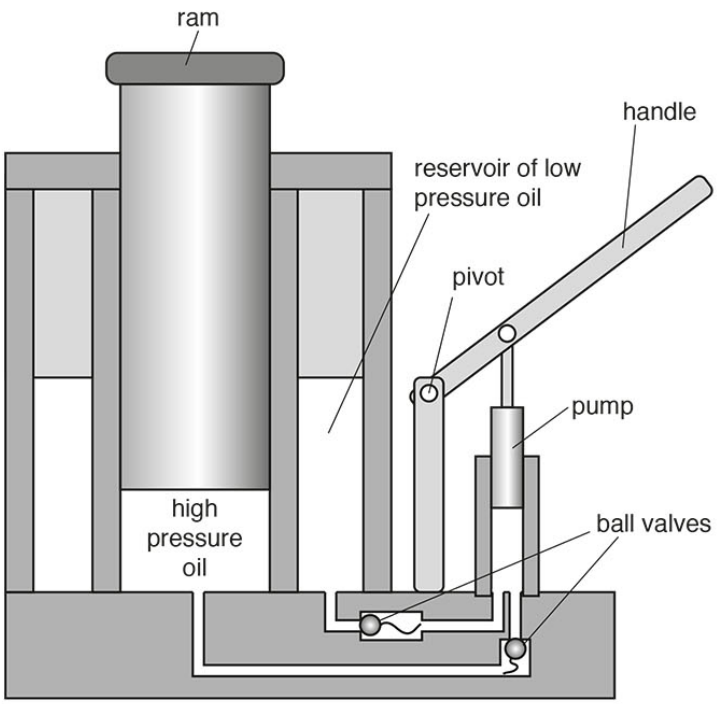


Fig. 7

(i) Explain in detail how effort from the operator is used to lift a load.

Up to four marks for an explanation e.g.:
The user cranks the handle which is attached to a small piston (1) controlling a low pressure circuit. (1) The low pressure circuit operates a ball valve to control the fluid from the reservoir (1) into the high pressure circuit. Increasing the volume of hydraulic fluid increases the pressure to lift the main piston/ram to lift the load (1).

Effort is applied to the handle (1) oil moves the ball valve (1) more oil/pressure in high pressure reservoir (1) oil fills up underneath the ram (1) the ram lifts the load (1)

..... **[4]**

(ii) Give **one** other example of a hydraulic machine.

One mark for and appropriate example e.g.:
- hydraulic arm/ram grab (1)
- lifting/access platform (1)
- vehicle ramp/lift (1)
- crane (1)
- digger/excavator (1)
- hydraulic press (1)
- hydraulic stair lift (1)

..... **[1]**

Mark Scheme Guidance

Question 5(a):

Award up to 3 marks for a correct explanation.

Allow other valid stages e.g. pressure regulation.

Question 5(b)(i):

Up to 4 marks for an appropriate explanation of the operation made up of relevant points to increase the pressure in a lifting mode, and/or reducing pressure to lower the load.

Question 5(b)(ii):

Accept other appropriate examples.

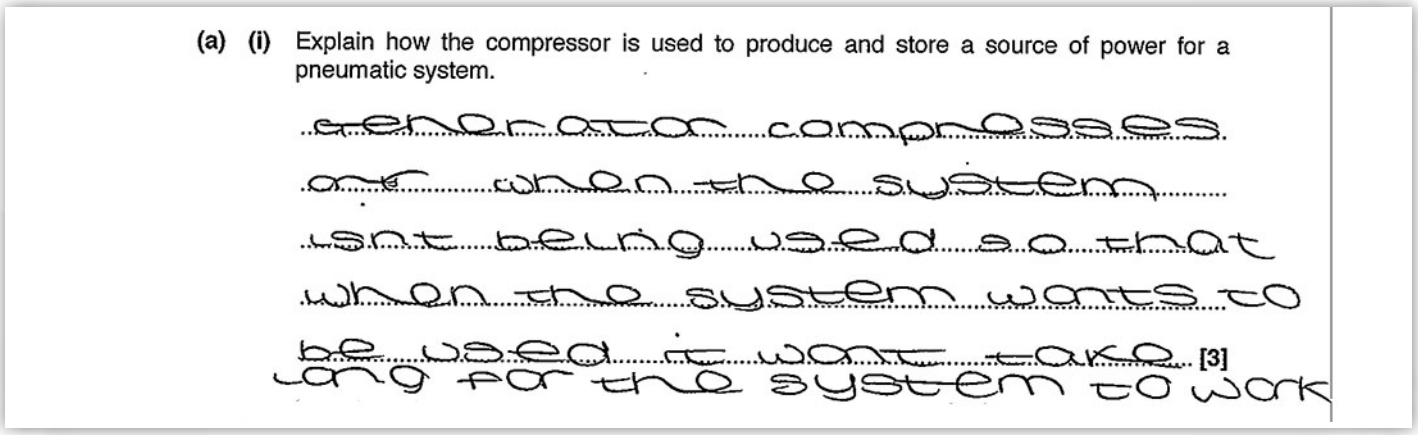
Examiner comments

Question 5(a) – This question was about using a compressor to produce and store power for a pneumatic system. Most responses lacked an explanation of how the compressor is used to produce power, however candidates were able to gain a mark for stating the compressed air is stored in the reservoir. Responses generally lacked technical terminology.

Question 5(a)(ii) – Although the diagram in Fig. 6 shows a pressure gauge, fewer candidates than expected correctly stated the use of a pressure gauge to measure system pressure.

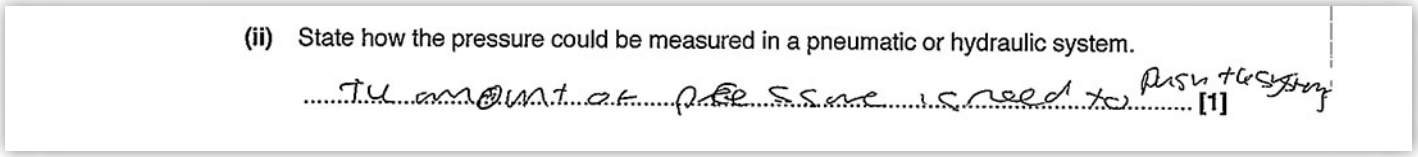
Question 5(b) – Candidates across the ability range answered this question well including references to the use of the ball valves.

Exemplar candidate work
Questions 5(a)(i), (ii), (iii) – Low level answers



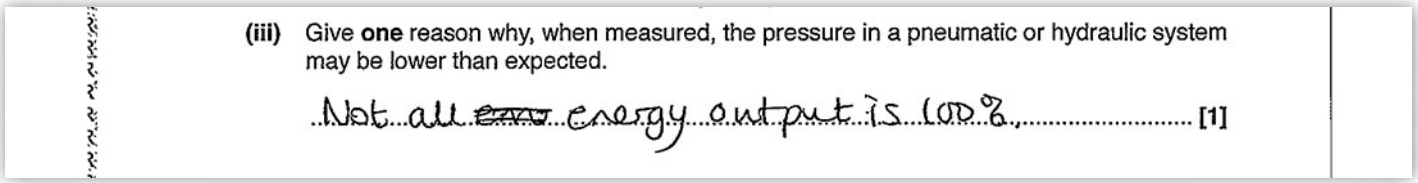
(a) (i) Explain how the compressor is used to produce and store a source of power for a pneumatic system.

generator compresses air when the system isnt being used so that when the system wants to be used it wont take long for the system to work [3]



(ii) State how the pressure could be measured in a pneumatic or hydraulic system.

the amount of pressure is need to push the system [1]



(iii) Give **one** reason why, when measured, the pressure in a pneumatic or hydraulic system may be lower than expected.

Not all energy output is 100% [1]

Commentary

Question 5(a)(i) – Some responses lacked an explanation of how the compressor is used to produce power, however candidates were able to gain a mark for stating the compressed air is stored in the reservoir. Responses generally lacked technical terminology. Candidates could improve their answers to become a medium level answer by including a reference to the motor being used to turn the compressor, or including a mention of a piston engine being used to draw in air.

Question 5(a)(ii) – Although the diagram in Fig. 6 shows a pressure gauge, fewer candidates than expected correctly stated the use of a pressure gauge to measure system pressure. Candidates achieving low level marks for this part gave inappropriate responses, missing the focus of the question of how the pressure could be measured.

Question 5(a)(iii) – Candidate responses about loss of energy as shown in the example, were not awarded marks and the answer is not specific enough to mean a system leak, or other correct reason for the system pressure to be lower than expected.

Exemplar candidate work
Questions 5(a)(i), (ii), (iii) – High level answers

(a) (i) Explain how the compressor is used to produce and store a source of power for a pneumatic system.

The tank contains high pressured air which is stored with the motor / engine allows the air and makes it pressurized, the air will travel along a tube going back and forward so the pneumatic system can expand and release to do the job it wants to. [3]

(ii) State how the pressure could be measured in a pneumatic or hydraulic system.

A pressure ~~gauge~~ gauge. [1]

(iii) Give **one** reason why, when measured, the pressure in a pneumatic or hydraulic system may be lower than expected.

Due it damages or leaks which will release the pressure. [1]

Commentary

Question 5(a)(i) – High level answers were those that included references to the compressed air being stored having been produced by the motor driven engine, and a system for the compressed air to be delivered to the pneumatic system, as shown. Although the answer shown could have been answered in a more methodical order, key components and their function were included to provide the high level answer.

Question 5(a)(ii) – Candidates correctly stated that the pressure could be measured using a pressure gauge.

Question 5(a)(iii) – Candidates correctly stated that if the pressured when measured was lower than expected, this could be caused by a leak.

Exemplar candidate work
Questions 5(b)(i), (ii) – Low level answers

(i) Explain in detail how effort from the operator is used to lift a load.

The handle is pushed which causes the ram releases or allows for high pressured oil to be put through pushing the pump up and down this allows for the handle to be lowered or raised depending on what liquid is being pumped through, it is raised because of the pivot which allows it to be. [4]

(ii) Give **one** other example of a hydraulic machine.

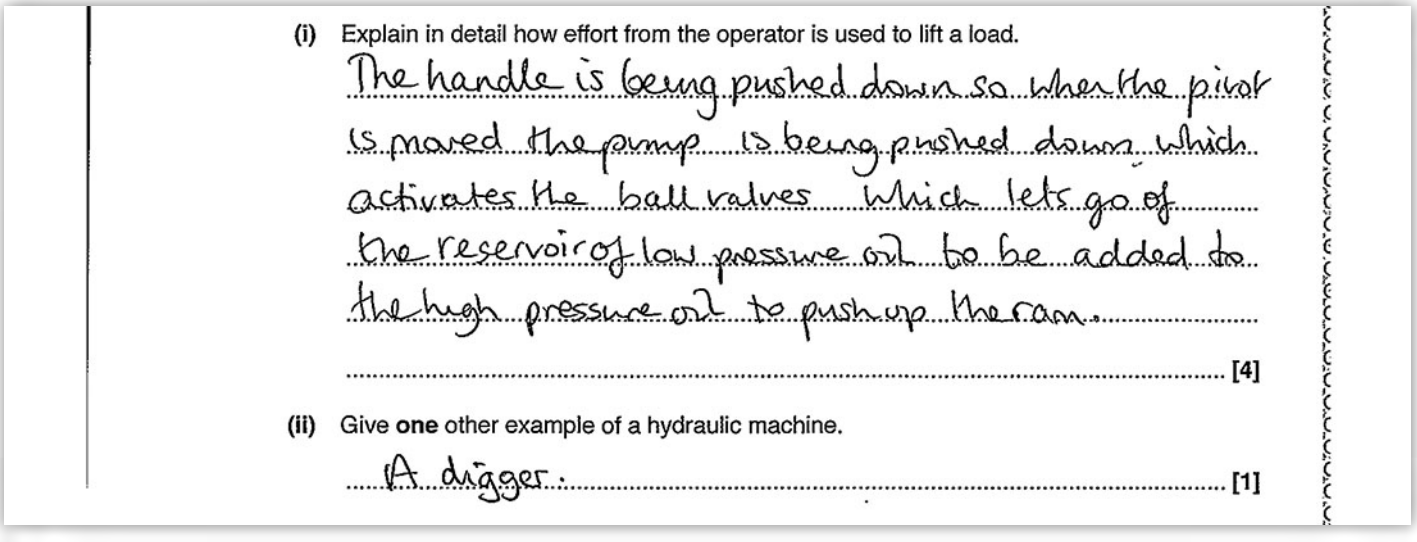
oil e.g. pump. [1]

Commentary

Question 5(b)(i) – Overall, candidates across the ability range answered this question well including references to the use of the ball valves, or similar reference to releasing fluid into the high pressure reservoir. Inclusion of the high pressure oil in this example demonstrates some understanding. The level of answer could have been improved to a medium level answer, if the candidate had started with their explanation of the handle being used to create the pressure, before their explanation of the high pressure circuit.

Question 5(b)(ii) – Candidates may have not read the question properly or did not give more obvious answers when considering their responses, as shown in this example.

Exemplar candidate work
Questions 5(b)(i), (ii) – High level answers



(i) Explain in detail how effort from the operator is used to lift a load.

The handle is being pushed down so when the pivot is moved the pump is being pushed down which activates the ball valves which lets go of the reservoir of low pressure oil to be added to the high pressure oil to push up the ram.

[4]

(ii) Give **one** other example of a hydraulic machine.

A digger.

[1]

Commentary

Question 5(b)(i) – Candidates gave high level answers where their answers started with an explanation of the handle being used to create the initial low pressure action to move the ball valve. The answer shown correctly references the low and high pressure reservoir, correctly using the technical terms to explain the operation of the operator lifting the load used in the hydraulic jack.

Question 5(b)(ii) – Candidates correctly gave an example of a hydraulic machine as shown in this candidate's answer.

Question 6

6 (a) Describe a control system that includes both electrical and pneumatic features combined to perform an operation in a factory.

Up to three marks for a description e.g.:
- Electronic scales [or other sensor] (1) weigh/scan the product (1) and a pneumatic cylinder (1) is used to push under limit /overweight products off the line.
- A control system (1) is used to energise a solenoid valve (1) and an actuator is used to stamp (1) the product to apply a label.
- A PLC (1) is used to automate the operation of an actuator (1) to assemble (1) the product.
- Electric motor (1) is used to move a conveyor belt (1) pneumatics arm seals the packaging (1)

[3]

(b) Give **one** example of a hydro mechanical application.

One mark from:
- Transmission/gearbox (1)
- Suspension (1)
- Power generation (1)

[1]

(c)* Discuss, using examples, the use of hydraulics in heavy industrial equipment.

Hydraulics are used in heavy industrical equipment due to the ability to apply a great amount of force.

Hydraulic fluid is pumped under pressure to enter the cylinder and hold heavy loads, or release to move the ram and lower a load.

Hydraulic fluid does not compress which makes it suitable for lifting and holding heavy loads, such as with platform lifts, and jacks.

Hydraulic cylinders and be controlled using control valves to stop at any linear point along the length of the cylinder making them suitable for manoeuvring in areas where space is limited or to control the depth of reach such as with a fork lift.

Several hydraulic cylinders/rams can be configured into an arm such as with excavating equipment to control a series of lifting, reaching, digging, scooping functions.

Two hydraulic cylinders can be interconnected to use a light mechanical effort to control a much heavier operation such as with a jack or hydraulic press.
Hydraulics can be used to create a hydraulic motor to produce a rotary motion.

[6]

Mark Scheme Guidance

Question 6(a):

Answers must contain at least one electrical and pneumatic example for full marks.

Question 6(c):

Award up to six marks for a discussion or detailed explanation of the advantages of using kinetic energy sources, with some comparison to other types of power generation such as the use of fossil fuels.

Level 3 (5 – 6 Marks)

Detailed discussion showing clear understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.

Specialist terms will be used appropriately and correctly. The information will be presented in a structured format. The candidate can demonstrate the accurate use of spelling, punctuation and grammar.

Level 2 (3 – 4 Marks)

Adequate discussion showing an understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.

There will be some use of specialist terms, although these may not be used appropriately. The information will be presented for the most part in a structured format. There may be occasional errors in spelling, punctuation and grammar.

Level 1 (0 – 2 Marks)

Basic discussion showing limited understanding of the advantages of using kinetic power sources compared to using non-sustainable sources.

There will be little or no specialist terms. Answers may well be ambiguous or disorganised. Errors of spelling, punctuation and grammar may be intrusive.

0 = a response that is irrelevant and/or not worthy of a mark.

Annotate with 'Seen' at the end of the response.

Examiner comments

Question 6(a) – Candidates performed less well than anticipated in their knowledge of applying and combining electrical and pneumatic applications. Marks were awarded for a feasible description.

Question 6(b) – Candidates generally struggled to state an appropriate example of a hydro-mechanical application, with candidates too often giving hydraulic applications appropriate to question 5(b)(ii).

Question 6(c) – The majority of candidates attempted this question, with most candidates achieving 2 or more marks. Lower achieving candidate responses were limited to the ability to lift heavy loads and references to excavator equipment. Higher attaining candidates correctly identified that fluids cannot be compressed, and some mentioned the use of a hydraulic pump to create the initial fluid pressure.

The candidates' Quality of Written Communication (QWC) was assessed in this question, and marks were awarded for well written answers, including where the technical content of the response was limited.

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