

Qualification title: Level 3 Advanced Technical Extended Diploma in Land-based Engineering (1080)
Test title: 0171-015/515 Level 3 in Land based Engineering – theory test (1)

Version: June 2019

Base mark: 60

Materials: non programmable calculator

1. Figure 1 shows a resistor which is supplied with a range of voltages. The voltage and current flowing through it is recorded using an ammeter.

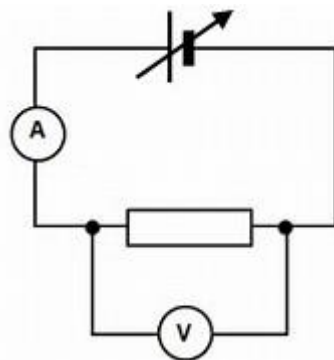


Figure 1

The readings taken are shown in Table 1

Supply voltage	0	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
Voltage drop	0	0.3	1.1	2.2	3.1	4.2	5	6	6.5	7.5
Current	0	0.06	0.21	0.42	0.6	0.75	0.9	1.1	1.3	1.5

Table 1

- Using the results in Table 1, calculate the value of the resistor. Show all your workings with the correct units. (3 marks)
- State the electrical theory which relates to 1a. (1 mark)
- Explain the relationship between the **three** units used in the calculation in 1a. (3 marks)

Answer:

- Up to 3 marks for the following

$$V = I \times R \text{ (1)}$$

$$\text{Transpose: } R = V/I \text{ (1)}$$

$$\text{Correct answer} = 5 \text{ Ohms (1)}$$

- 1 mark for Ohms law

c) Up to 3 marks for the following explanation :

(V) voltage flowing across a conductor (1) or (R) resistor is directionally proportional (1) to the (I) current flow (1) (if temperature remains constant)

Accept any other suitable answer

**Test spec reference: 350 AO1 AO2 1.1 1.4
1.5**

Total marks: 7

2.

a) State the unit used to measure the fuel consumption of an agricultural tractor. (1 mark)

b) Explain why the unit given in 2a) is **not** realistic when comparing differing tractor fuel consumptions. (2 marks)

c) Explain the importance of g/kWh in relation to fuel consumption measurement in an agricultural tractor. (2 marks)

Answer:

a) L/hr or Litres per hour - 1 mark

b) Up to 2 marks for explanation

Fuel consumptions vary with engine size or power (1) and working situations (1)

c) Up to 2 marks for explanation

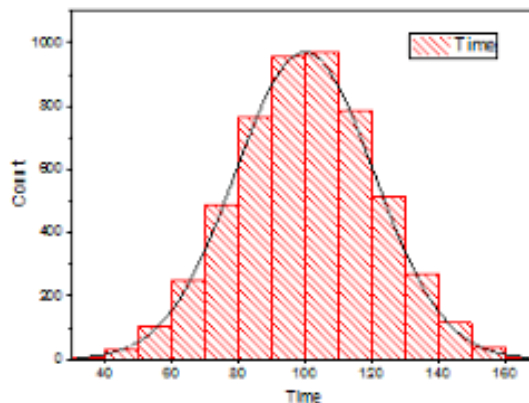
Grams per kilo watt hour (g/kWh) is a more meaningful measurement of fuel used (1) and takes into consideration the density of the fuel and engine power (1).

Note to marker: accept reference to operating conditions e.g. heavy and light work in relation to making the measurement more meaningful.

Accept any other suitable answers.

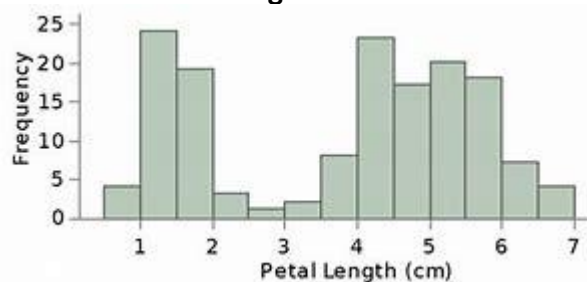
Test spec reference: 350 AO1 1.1, AO2 1.1

Total marks: 5



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Figure 2



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Figure 3

- a) Name the **two** types of bar chart shown in Figures 2 and 3. (2 marks)
- b) Using the information in Table 2, calculate the mean of the lead acid battery cell readings correct to **two** decimal places. Show all workings. (2 marks)

Table 2

Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
1.265	1.273	1.256	1.260	1.269	1.274

Answer:

a)

- Frequency distribution (1)
- Histogram (1)

- b) 1 mark for the correct calculation (sum of Cell 1 to 6 divided by number of cells) -
 $7.5976 = 1.2661$
 1 mark for correct answer to two decimal places (1.27)
 Do not accept 1.26

4. The following engine components have a range of settings. Calculate the minimum and maximum ranges for **each**.

- a) Nut securing compressor gear: 125 ± 19 Nm (2 marks)
- b) Bolts securing timing gear: 36 ± 4 Nm (2 marks)
- c) Unions securing piston lubrication nozzles: 15 ± 3 Nm (2 marks)

Answer:

1 mark for the minimum and 1 mark for the maximum –up to 6 marks

- a) 106 (1) to 144 (1)
- b) 32 (1) to 40 (1)
- c) 12 (1) to 18 (1)

Test spec reference: 350 AO2 1.2

Total marks: 6

5. State the formula for torque and state the metric units used. (2 marks)

Answer:

1 mark for formula - Torque= force x distance

1 mark for unit – Nm = N x m (Newton meters= newton x meters)

Test spec reference: 350 AO1 1.4

Total marks: 2

6.

- a) State what each of the following abbreviations stands for. (3 marks)
 - i) EGR
 - ii) DEF
 - iii) DPF
- b) Explain the principle of operation for each system in 6a), in relation to engine emissions. (9 marks)

Answer:

- a) 1 mark each – up to 3 marks
 - i. Exhaust gas Recirculation (1)
 - ii. Diesel Exhaust Fluid (1)
 - iii. Diesel Particulate Filter (1)

b) 3 marks each per explanation – up to 9 marks

- i) Exhaust gas Recirculation emission control technology key points reduces NO_x (1) meet exhaust emission legal limits (1), some are cooled to reduce temperature rise in combustion temperature. (1)

Note to marker: send to combustion on its own is not enough must mention particulates or emissions

- ii) Diesel Exhaust Fluid is an additive containing Urea. (1) injected into the exhaust to reduce NO_x (1), used with SCR Selective catalyst reduction unit (1).
- iii) DPF Diesel Particulate Filter is used to reduce Particulate Matter (PM) (1). It uses honey comb internal structure to remove particulates (1). It also reduces the amount of NO_x gases produced, since the combustion chamber does not reach the temperatures required for excess levels of NO_x gases to form. (1)

Accept any other suitable answer

Test spec reference: 352 A02 1.5 A01 1.5

Total marks: 12

7

- a) Explain the **main** function of **each** of the following components in a 4-stroke petrol engine.
- Top piston ring. (2 marks)
 - Crankshaft. (2 marks)
 - Rocker arm. (2 marks)
- b) Give **three** consequences of **not** applying a torque tightening sequence of the cylinder head. (3 marks)

Answer

- a)
- To seal combustion pressure (1) to prevent compression loss (1)
 - To convert reciprocating motion of piston into a rotary motion (1) in order to transmit torque (1)
 - To transfer the lift of the camshaft (1) to open inlet/exhaust valves (1)

Note to marker: for 7ai) allow: the top piston ring's main function is compression
For 7aii) allow to create drive

b) 1 Mark per consequence to a maximum of 3 marks

- Cylinder head distortion (1)
- Coolant loss (1)
- Compression loss (1)
- Lubricating oil loss (1)
- Ineffective sealing of wet liners (1)
- Ineffective seal between cylinder head and cylinder block (1)

Any other suitable answer.

Test spec reference: 353 A02 (9) 1.1

8.

What is the function of an internal combustion engine? (1 mark)

Answer:

To convert heat energy into mechanical energy. (1)

Accept any other suitable answer

Test spec reference: 353 – A01 1.1

Total marks: 1

9. One of the **main** functions of a lubrication system in a typical land-based engine is to reduce friction.

State **two** other functions of this system. (2 marks)

Answer:

1 mark each from any of the following, up to 2 marks

- To act as a coolant (1)
- To act as a seal (1)
- To flush away debris. (1)
- To clean engine components.(1)

Accept any other suitable answer.

Test spec reference: 353 1.2 A01

Total marks: 2

10.

A warning light on the dashboard of a common rail diesel engine is indicating that there is water in the fuel system and the engine is running erratically.

Propose a diagnostic, repair and testing procedure, including the prevention of reoccurrence and any typical readings to be taken. (12 marks)

Indicative content

- Warning light displayed, sample analysed (visual and tester), viewed in glass bowls, poor or non-running, misfire, stalling, erratic running, limp mode.
- Drain system, flush through, remove fuel tank, lines, filters and fuel injection components inspected and or replace. Black or white exhaust smoke
- Correct fuel storage, not using small top up containers, known fuel store/age, secure fuel caps, operator error.
- Pressure tests. Feed pump 2 to 5 bars.
- Pressure tests. HPCR to the rail/injectors at about 200 bars during cranking, 300 bars at idle and from 1200 to 1800 bars running.
- Leak back from injectors typically 20 to 50 cc

Band 1 (1-4 marks)

Limited proposal demonstrating **limited** understanding of the diagnostic process with a **limited** range and depth with regards to the steps required. **Vague** links made in the diagnostic process **or** to repair and testing procedure, with **limited** reference to prevention of reoccurrence and any typical readings to be taken. To access the higher marks in the band, learners will attempt to order their diagnostic, repair and testing response in a logical manner with **limited** success, showing **some** attention to diagnostic, repair and testing detail.

Band 2 (5-8 marks)

Detailed proposal demonstrating **clear** understanding of the diagnostic process with **some** range and depth with regards to the steps required. **Some clear** links made in the diagnostic process **and** to repair and testing procedure, with **some** reference to prevention of reoccurrence and any typical readings to be taken. To access the higher marks in the band, learners will attempt to order their diagnostic, repair and testing response in a logical manner with **some** success, showing **clear** attention to diagnostic, repair and testing detail.

Band 3 (9 -12 marks)

Comprehensive discussion demonstrating **thorough** understanding of the diagnostic process with an **extensive** range and depth with regards to the steps required. **Clear and relevant** links

made in the diagnostic process **and** to repair and testing procedure, with **clear** reference to prevention of reoccurrence and any typical readings to be taken. To access the higher marks in the band, learners will order their diagnostic, repair and testing response in a logical manner **successfully** with focus, showing **comprehensive** attention to diagnostic, repair and testing detail.

**Test spec reference: 352 A04 1.4 350 A02
1.1**

Total marks: 12