GCE A2

Technology and Design

Summer 2009

Mark Scheme

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE) AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2009)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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2009

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assessing

Unit 6 – Systems and Control in Product Design

[A2V31]

TUESDAY 19 MAY, MORNING

MARK
SCHEME

Answer either 1(a) or 1(b)

In all cases suitable alternative responses will be given full credit.

1 (a) **Electrical/Microelectronic**

    (i) Select and justify **one** suitable manufacturing process for the tank.
        Injection Moulding – good surface finish from a single process   [2]

    (ii) Any **two** main reasons why box section mild steel would be used for
        the frame from the following:
        •   Good strength to weight ratio
        •   Readily available as a standard material and stock sizes
        •   Suitable for secondary, assembly and finishing processes   [2]

    (iii) State **two** specific manufacturing processes that the box section mild
        steel would have gone through in order to produce the frame
        •   Mitre Cut
        •   Welding/Brazing   [2]

    (iv) **Two** alternative methods that could be used to detect when the water/
        detergent tank is empty
        (i)   use of a float switch   [2]
        (ii) use of sensors   [2]

    (v) **Bullet point 1**
        Monostable timer with correct values for 2 minute delay – triggered
        by a momentary switch
        Or PIC based circuit with appropriate program   [5]

        Bullet point 2
        Signal to base of transistor/relay circuit with secondary circuit to
        motors   [5]

        Bullet point 3
        Microswitch to counter/decoder and 7 segment displays
        Logic to detect 50 count and latch and alarm with reset
        Or PIC based circuit with appropriate program   [12]

        Bullet point 4
        Motor reversing circuit with limit switches and resistor to control
        speed   [6]

(b) Pneumatic and Mechanical

(i) Select and justify **one** suitable manufacturing process for the tank
Injection Moulding – good surface finish from a single process [2]

(ii) Any **two** main reasons why box section mild steel would be used for
the frame from the following:
• Good strength to weight ratio
• Readily available as a standard material and stock sizes
• Suitable for secondary, assembly and finishing processes [2]

(iii) State **two** specific manufacturing processes that the box section mild
steel would have gone through in order to produce the frame
• Mitre Cut
• Welding/Brazing [2]

(iv) Two alternative methods that could be used to detect when the water/
detergent tank is empty
(i) use of a float switch with 3PV [2]
(ii) use of an air bleed or switches/sensors [2]

(v) Bullet point 1
Annotated sketch of a ball and socket joint or other suitable
mechanism [5]

Bullet point 2
Annotated sketch of a thrust bearing or nylon bush with an appropriate
sized housing or bearing support [5]

Bullet point 3

Detection of sun lamps	solenoid	[2]
unlock	A+	[1]
Pull down handle	B+	[1]
Open door slowly 90 degrees	C+ slowly	[1]
Close door quickly 90 degrees	C−	[1]
Pull up handle	B −	[1]
Lock door	A−	[1]
Sequence functioning correctly		[4]

[12]

Bullet point 4
Sketch of two cams designed with slow lift and quick fall. Secured to
shafts by a flat and grub screw or other suitable mechanism [6]

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Section A 38

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Section B

Electronic/Microelectronic Systems

Answer **both** questions in this section

2 **(a)** **(i)** Labelled phototransistor symbol – junctions exposed to IR light Current
flows from collector to emitter as light intensity increases [2]

(ii) Draw a truth table relating **A**, **B**, **C**, and **F**

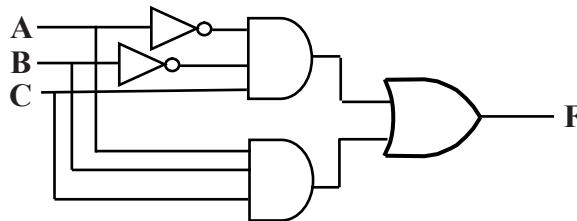| A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

[2]

(iii) Logic expression for F
F=A'B'C + ABC [2]

(iv) Draw a logic circuit for F

[2]

(b) **(i)** Strain causes deformation which in turn causes a change in resistance
of the guage [1]

(ii) A clear sketch with passive axis identified [2]

(iii) Both gauges will experience temperature change since they are close
together but only gauge one will experience active axis change in
strain [2]
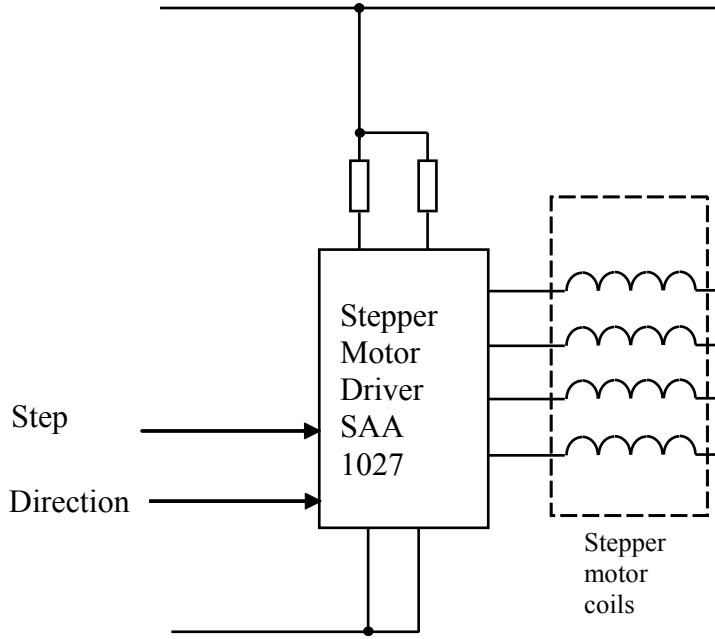
(c) **(i)** $V_1 = 2.5$ V, $V_2 = 2.5125$ V [3]

(ii) Gain $= \frac{50k}{1k} = 50$ 50 (2.5125 – 2.5) = 0.625 V [3]

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3 **(a)** **(i)** Ease of positional control – can be stopped exactly where required
Ease of speed control speed – without overshoot [2]

(ii)

Stepper
Motor
Driver
SAA
1027

Step

Direction

Stepper
motor
coils [3]

(iii) 30 cm in 5 seconds or 6 mm/sec   60/0.1 = 600 pulses per second [2]

(iv) Period 120 ms amplitude 12.5 Volts [2]

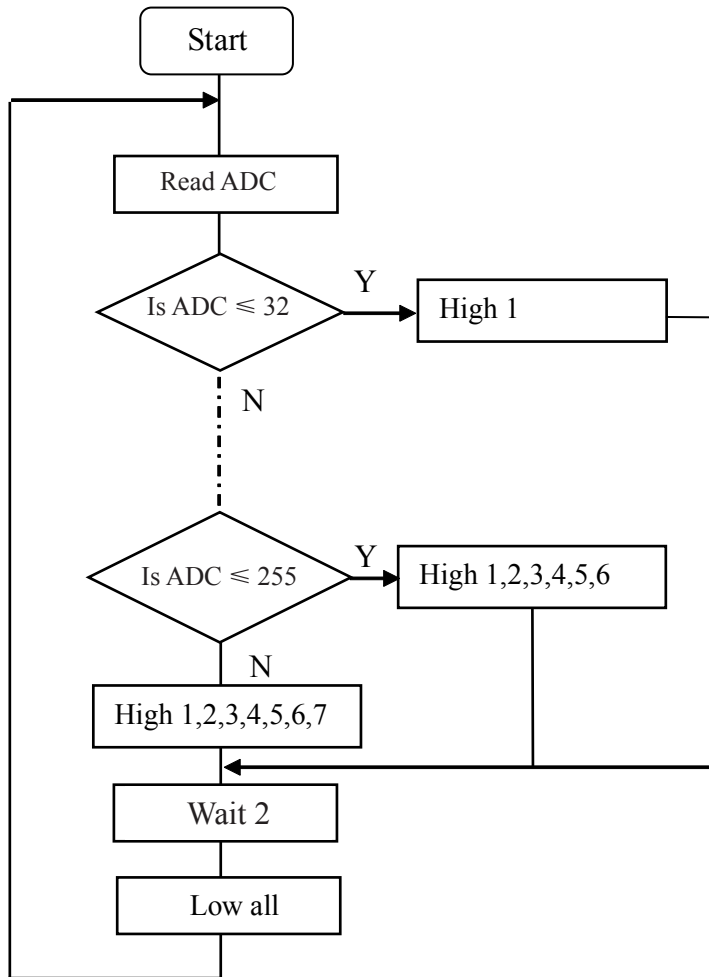**(b)** **(i)** 3.9 Volts at 45 degrees   4.36 Volts at 65 degrees [2]

(ii)

Cathodes are connected [2]

(iii)

Start

Read ADC

Is ADC ≤ 32 —Y→ High 1

N

Is ADC ≤ 255 —Y→ High 1,2,3,4,5,6

N

High 1,2,3,4,5,6,7

Wait 2

Low all

[6]   19

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Section C

Pneumatic and Mechanical Systems

Answer **both** questions in this section

4   **Fig. 4 (a)** shows part of a mechanical system using gears and pulleys

(a) (i) The mechanism will require constant lubrication to reduce friction
Briefly describe one unwanted side effect associated with friction in a
mechanical system
Ans = Heat or wear
Or other suitable answer   [1]

   (ii) Briefly outline the main features of a multigrade oil
Ans = Viscosity changes with heat   [1]
Cold – low viscosity (thin). Hot – high viscosity   [1]

   (iii) The shafts holding the gears were not positioned at right angles to the
sides of the gearbox housing and sit a few degrees out of line. In your
answer booklet name and draw a suitable bearing arrangement which
could accommodate this slight inaccuracy
Ans = Self aligning bearing   [1]
Suitable sketch of self aligning bearing   [2]

   (iv) Calculate the output torque on Gear **C** if there is an input torque on
Gear **A** of 150 Nm
Ans = Output torque = Input torque × VR
VR = No T driven/No T driver
VR = 80/160 = 0.5   [1]
OT =150 × 0.5 = 75 Nm   [1]

   (v) Calculate the overall velocity ratio of the mechanical system
between **A** and **O**
Ans = VR = No T driven/ No T driver
A–C = 80/160 = 0.5
D–E = 80/160 = 0.5
F–G = 60/60 = 1
H–I = 60/60 = 1
Worm–J = 60/1 = 60
K–L = 100/50 = 2
M–O = 100/100 = 1
Tot VR = 0.5 × 0.5 × 1 × 1 × 60 × 2 × 1 = 30   [5]

(b) Fig. 4 (b) shows a linkage system

   (i) Briefly describe the main difference between static and dynamic friction in relation to force
      Ans = During movement the friction force required to maintain movement is less than the static friction   [2]

   (ii) The resistance to movement at **R** is 100 N. Calculate the size of force **F** required to overcome the resistance
       Ans = 100 N × 150 mm = 15 000 Nmm
       15 000 Nmm/200 mm = 75 N
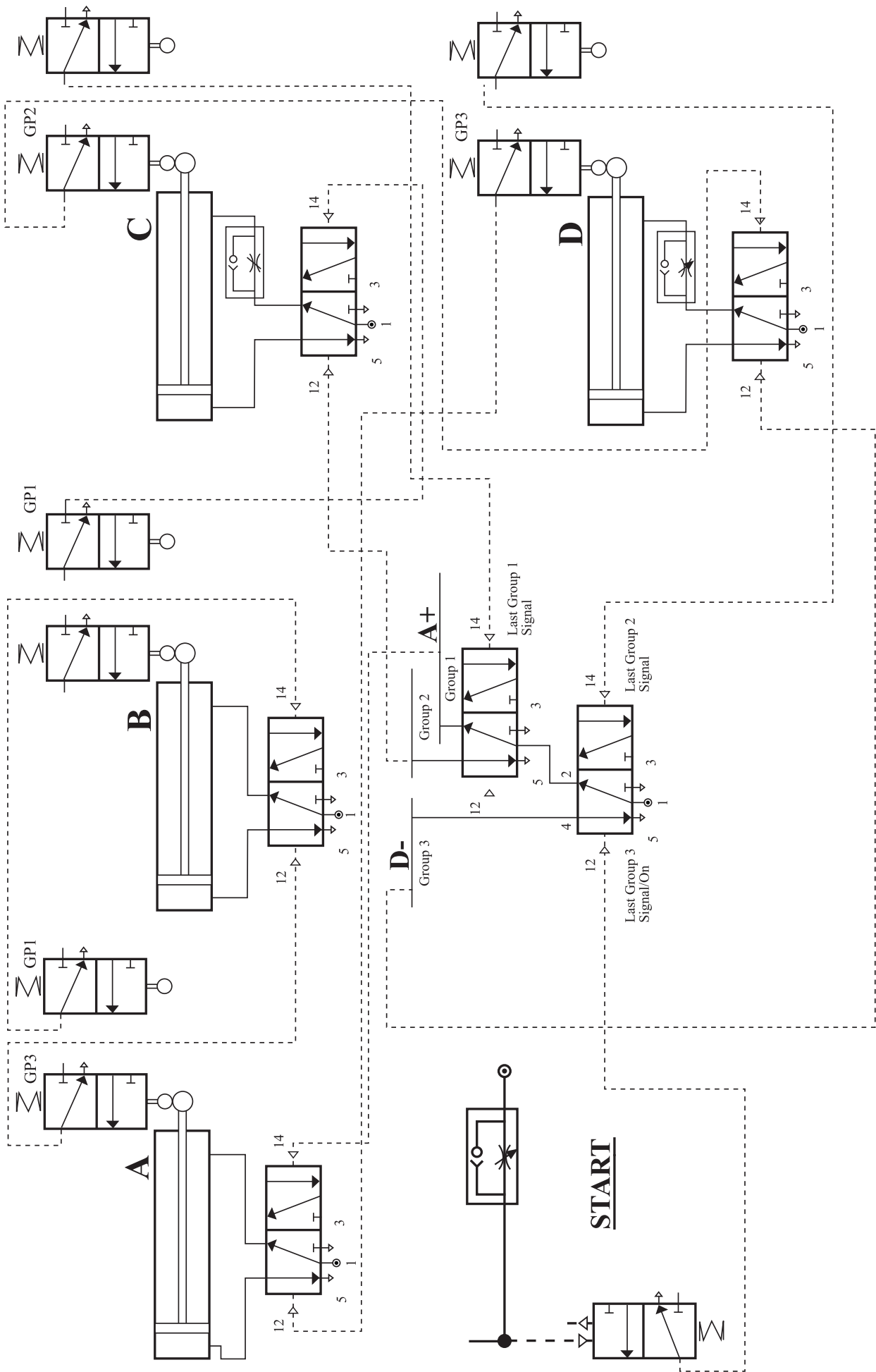   50 mm × 75 N + 200 mm × 50 N/400 = 34.4 N   [4]   19

5 **(a)** **(i)** Briefly state what is meant by the term positive feedback technique when
applied to pneumatic systems
Ans = Ensures that each step in the sequence must be followed in order
Or other suitable answer [1]

(ii) A double acting cylinder has a stroke length of 110 mm and exerts a
force during the outstroke of 400 N. Assuming an efficiency of 95%,
calculate the work done on the outstroke
Ans = 400 N produced at 95% eff
$400 \times 100/95 = 421$ N
421 N produced at 100%
$WD = F \times L$
$421 \times 0.11 = 46.31$J [3]

(iii) A double acting cylinder operates with an air pressure of 0.4 N/mm²
and a piston diameter of 50 mm. During operation it produces a force of
753.6 N during the instroke. A second double acting cylinder with the
same piston rod diameter and an air pressure of 0.5 N/ mm² produces a
force of 2472.75 N during the instroke
Calculate the piston radius of the second double acting cylinder
Please assume $\pi = 3.14$

Ans = $3.14 \times 25 \times 25 = 1962.5$ mm²
$1962.5 \times 0.4 = 785$ N
$785 - 753.6 = 31.4$ N
$31.4/0.4 = 78.5$
$78.5/3.14 = 25 = 5$ mm is rod radius
$5 \times 5 \times 3.14 = 78.5$
$78.5 \times 0.5 = 39.25$
$2472.75 + 39.25 = 2512$ N
$2512/0.5 = 5024$
$5024/3.14 = 1600 = 40$ mm is piston radius. [5]

(iv) **Fig. 5 (a)** shows part of a production line. The **Start** valve which is to be
activated using an air bleed signals the start of the following pneumatic
sequence:
*   Cylinder A goes positive lowering Cylinder B
*   Cylinder B goes positive pushing block 1 onto the conveyor belt
*   Cylinder C goes positive **slowly** pressing block 1
*   Cylinder C goes negative
*   Cylinder D goes positive **slowly** drilling block 1
*   Cylinder D goes negative
*   Cylinder A goes negative
*   Cylinder B goes negative

On the pro forma provided (answer **5(b)(i)**) draw a suitable interlocking/ cascade sequential pneumatic circuit to achieve the desired sequence

Method of activating cylinder A+	[1]	
Method of activating cylinder B+	[1]	
Method of activating cylinder C+ slowly	[1]	
Method of activating cylinder C–	[1]	
Method of activating cylinder D+ slowly	[1]	
Method of activating cylinder D–	[1]	
Method of activating cylinder A–	[1]	
Method of activating cylinder B–	[1]	
Air bleed activation+ group system	[2]	19

Section C		**38**

Answer number 5(a)(iv)

Quality of written communication.

Poor selection and use of a writing form and style appropriate to the content. The script content is poorly organised and little use is made of appropriate Technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation is inaccurate.	1–2
Good selection and use of a writing form and style appropriate to the content. The script content is organised and use is made of appropriate Technological vocabulary. The writing is legible and the spelling, grammar and punctuation is accurate.	3
Very good selection and use of a writing form and style appropriate to the content. The script content is well organised and good use is made of appropriate Technological vocabulary. The writing is clearly legible and the spelling, grammar and punctuation is very accurate.	4

[4] 4

Total **80**