Rewarding Learning

ADVANCED
General Certificate of Education
January 2012

Technology and Design

Assessment Unit A2 1

assessing

Product Design and Systems and Control

[AV211]

TUESDAY 31 JANUARY, MORNING

MARK SCHEME

General Marking Instructions

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

Quality of candidates' responses

In marking the examination papers, examiners will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

Flexibility in marking

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected for 17- and 18-year-old candidates. Conversely, marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

Types of mark schemes

Mark schemes for questions which required candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form.

In all cases, correct alternative responses will be given full credit.

AVAILABLE MARKS

Section A

1 (a) (i) To provide a voltage that changes with temperature. [1]

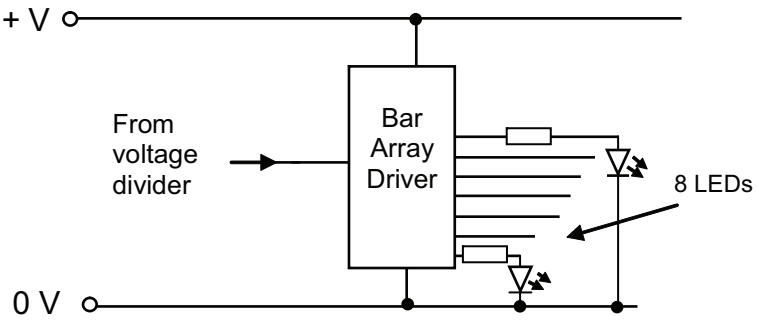
(ii) The thermistor used in this example has a negative temperature co-efficient. This means that the resistance of the thermistor will decrease as the temperature increases. Voltage Vo will increase as temperature increases. [2]

(iii) Resistance of thermistor at 15 °C = 4 k
Voltage across R_t = 9 – 3 = 6 V
Therefore R_1 = 2 k [3]

(b) (i) Sketch and annotation to include:
Common cathode means that all the LED cathodes are connected to the negative supply rail while each anode can be individually connected to a supply voltage. [2]

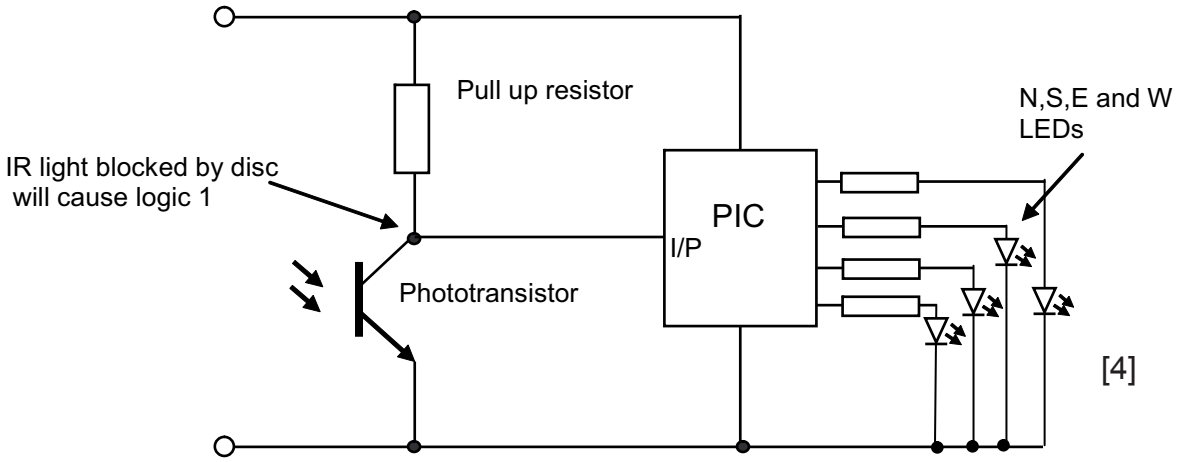
(ii) Advantages – durability, visibility in bright ambient conditions.
Disadvantage – power consumption. [3]

(iii) Sample answer



[3]

(c) (i)



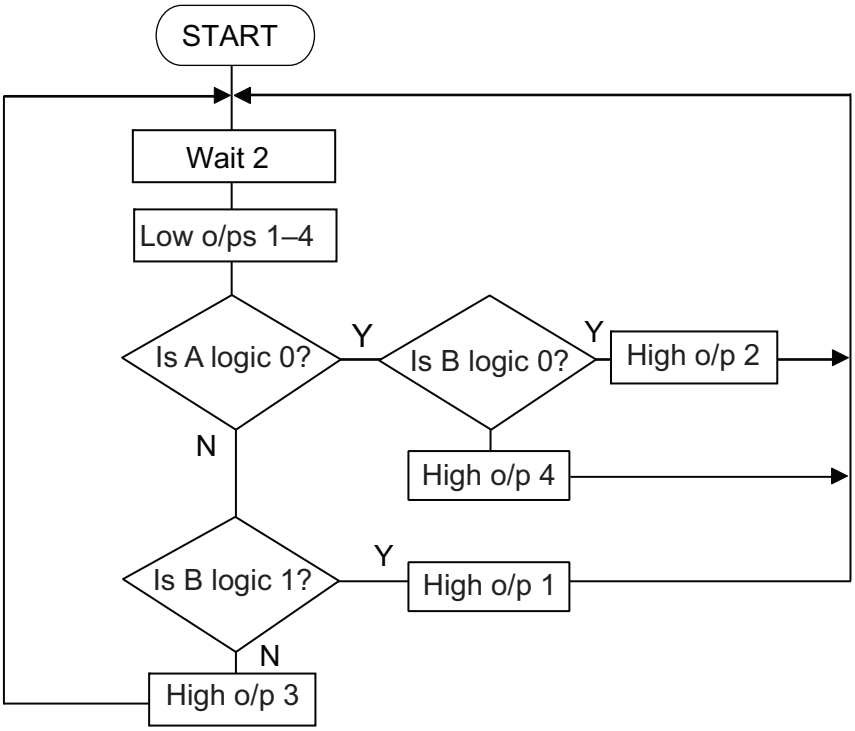
[4]

(ii) Truth table

Dir.	A	B
N	1	1
E	0	0
S	1	0
W	0	1

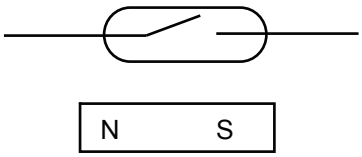
[3]

(iii) Sample answer



[6]

(d) **(i)** Suitable sensor, e.g. Reed switch and magnet

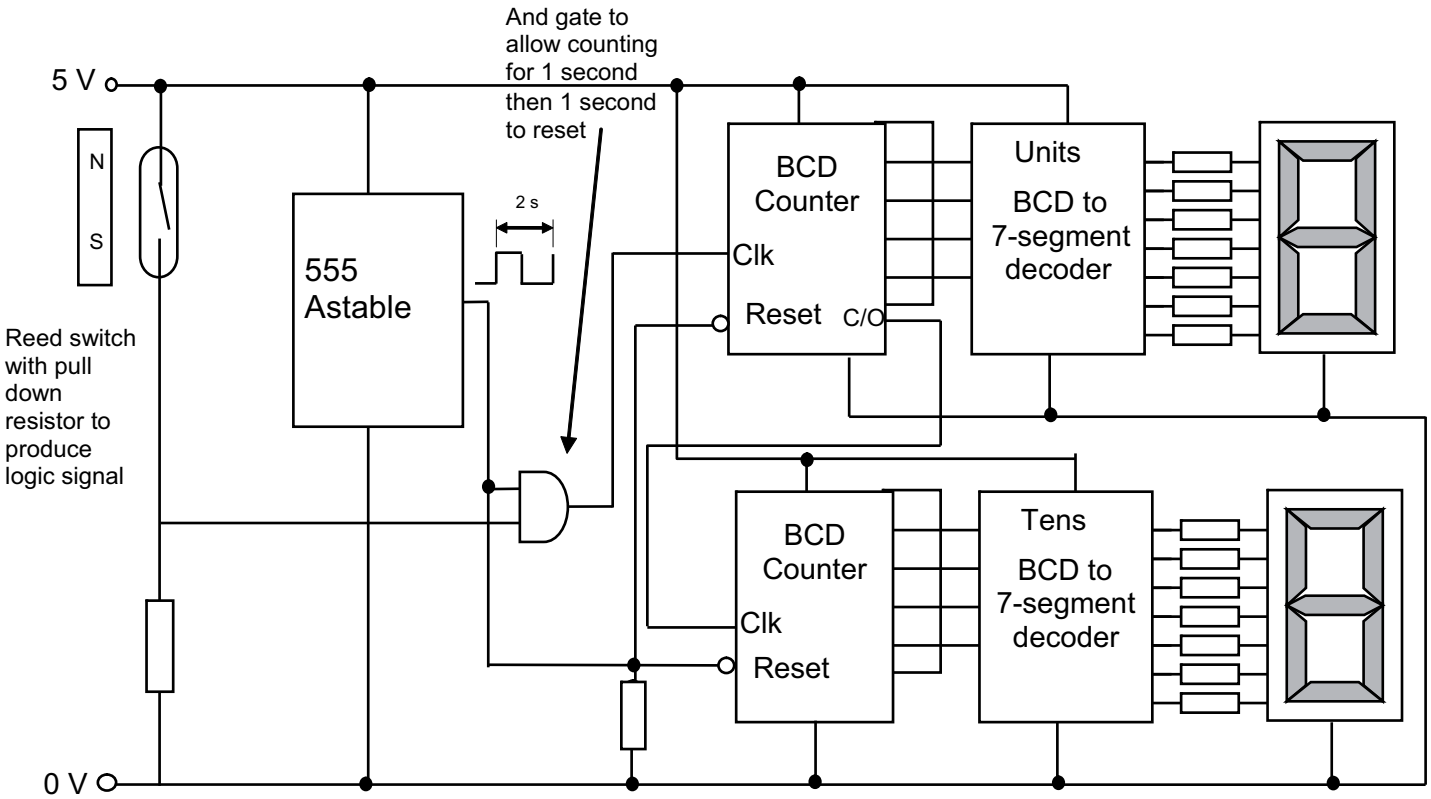


[2]

Description of operation [1]

AVAILABLE MARKS

(ii) Sample answer

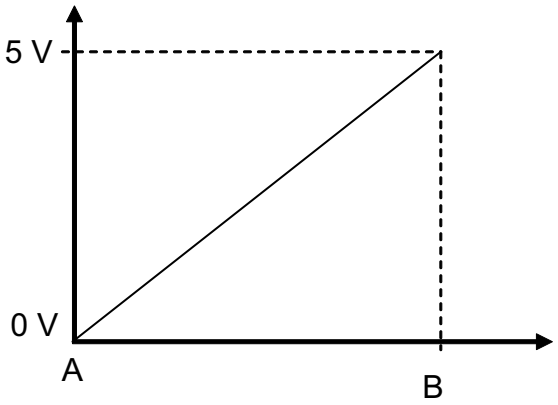


[10]

AVAILABLE MARKS

40

2 **(a)** Sketch graph



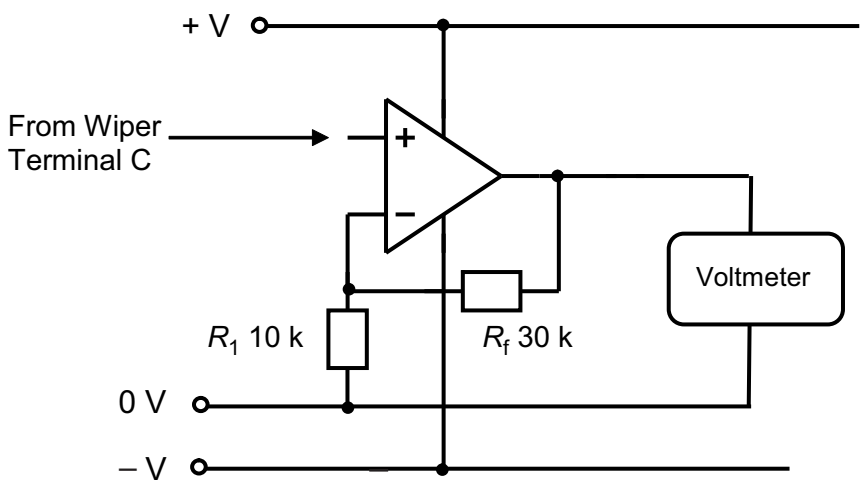
[2]

(b) **(i)** As the wiper of the variable resistor moves the resistance and hence the voltage out changes. If the variable resistor has a linear resistance track the voltage out will represent the distance moved. [3]

(ii) If 250 mV for each mm moved then ×4 required to amplify to 1 Volt for meter
Therefore gain = 4 [2]

AVAILABLE MARKS

(iii)

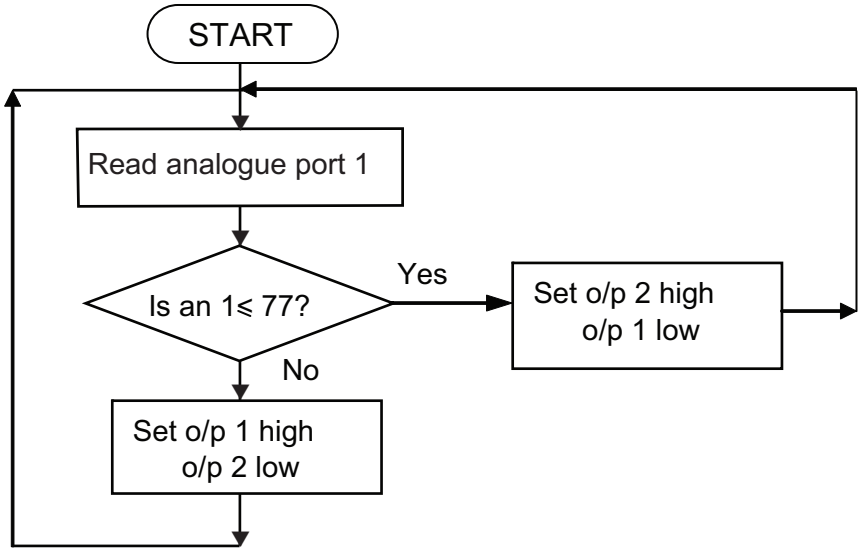


[5]

(c) **(i)** 750 mV = 77
1.25 V = 128 [2]

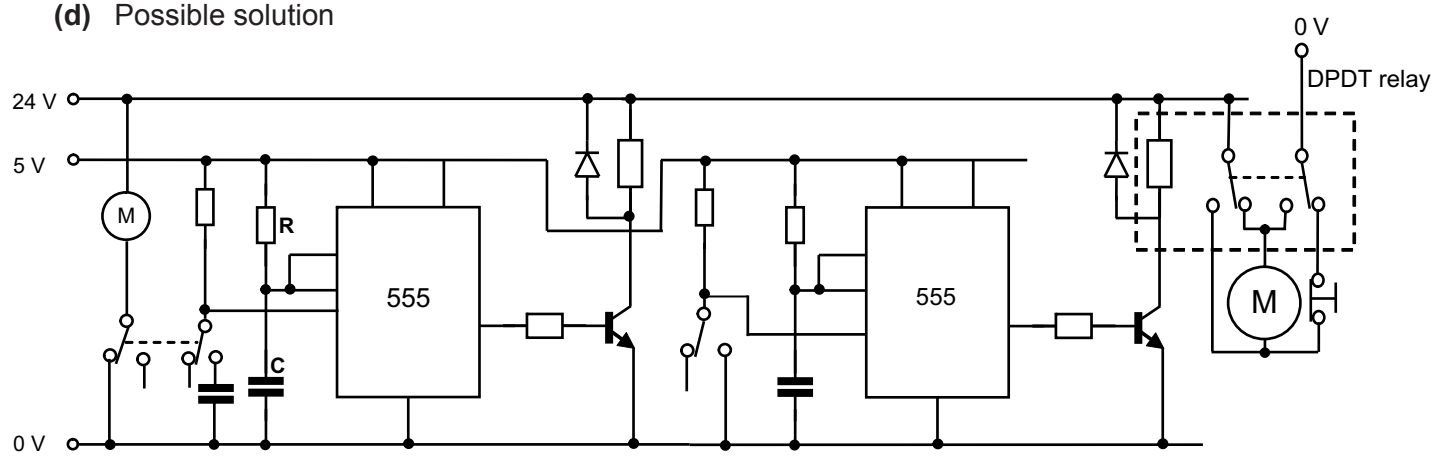
(ii) Power dissipation of 10 k = $5^2/10 \times 10^3$ = 2.5 mw
Power dissipation of 1 k = 25 mw
Difference = 22.5 mw
Justification of choice for 1 k [2]

(iii) Sample flowchart



[5]

(d) Possible solution



Microswitch to detect component. Will stop motor and trigger the monostable timer.

Solenoid moves out to measure component. Will spring return after 0.25 seconds. Determined by 1.1CR

Microswitch operated when solenoid has moved forward.

Motor begins to move forward slowly (solenoid will have retracted when mechanical arm reaches component). Relay will reverse motor after 0.5 seconds and stop when limit switch activated.

[10]

(e) Answer likely to refer to the following:
On off control refers to a type of output with no more than two states such as high/low on/off up/down left/right, e.g. electric kettle element on/off.
Continuous outputs can be varied in level and intensity, e.g. cooling fan in a laptop can run at various speeds depending on requirements.
Main difference between open and closed loop systems – the presence of feedback – description of feedback.
Factors influencing choice could be those of cost, safety or tolerance.

[5]

Zero should be awarded for a response which is not worthy of any credit.	0
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 Technology vocabulary. The writing is clearly legible and the spelling, grammar and punctuation is very accurate.	4

[4]

Section A

AVAILABLE MARKS
40
80

Section B

AVAILABLE MARKS

3 **(a)** **(i)** Explanation – Has a minimum of two pairs of meshing gears where the gear shafts are parallel. The compound gear train has a driver gear and a driven gear with intermediate gears fixed on a common shaft. [2]

(ii) 10 revs in 1 minute
1 rev in 6 seconds
$\frac{1}{2}$ rev in 3 seconds

Sketch of cam profile showing 180° dwell and 180° activation. [4]

(iii) Treadle linkage [1]
Sketch of linkage [2]

(b) **(i)** Sketch of four pulleys, correct rope and hook position [2]
Annotation [1]
The lifting device has four pulleys which divide the rope into 4 parts.
Each part supports $\frac{1}{4}$ of the load. The system therefore has a mechanical advantage of 4. [1]

(ii) P = work/time
P = 8000 N × 1.8 m/30 sec
P = 480 W

P = 480 × 120/100

P = 576 W [3]

(c) Clutch – housing, friction plate, pressure plate, clutch springs and method of operation [4]
Annotation/explanation [1]

(d) Purpose – to separate two contacting surfaces. This will reduce friction and reduce heat and wear.

Mechanics of lubrication and viscosity – lubricant can be a liquid (oil) or a semi-solid (grease). They produce a very fine film separating surfaces. Oils have to operate under various loads, speeds and temperatures. Different oils have different properties. Oils become thinner as they get hotter and therefore change their resistance to flow and shape.
Viscosity is the resistance of an oil to flow. Thin oils have a low viscosity, thick oils have a high viscosity. The viscosity of an oil is classified by SAE rating.

Factors – Heavy load of the car and the speeds involved with the gearbox.
Temperature of environment [5]

Quality of written communication

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[4]

AVAILABLE MARKS

(e) Constant velocity joint [3]
Joining of shafts, e.g. key and keyway [2]

1.6 m in 20 seconds when 1 rpm moves bracket 20 mm

1600/20 = 80 rpm
80 rpm × 3 = 240 rpm Output speed

7680 rpm Input — 240 rpm Output

Velocity Ratio 32 : 1
Achieved by 4 : 1
4 : 1
2 : 1

E.g. Shaft A = 20 T
Shaft B = 80 T 20 T
Shaft C 80 T
Shaft D Idler 20 T
Shaft E 40 T

[5]

40

4 (a)
- Trapped fingers with moving parts – use of guards over specific components, reduction of air pressure and repeating of briefing on safety instructions.
- Pipe work not secured resulting in whiplash from air line – wearing of goggles, reduction of air pressure and repeating of briefing on safety instructions.
- Working air pressure is too high – check compressor unit and regulate supply, advise at briefing the individual settings for pressure.

[4]

AVAILABLE MARKS

(b) **(i)** When valve A is pressed this will reset valve B and activate the 14 of the 5PV sending the DAC positive rapidly. When the piston rod activates the one way roller trip 3PV this will activate the 12 side of valve B. This will result in the exhaust air from the DAC passing through the 5PV and valve B via port 2 and 1 and then being restricted causing the remaining part of the stroke to slow down. The operator can activate the 3PV to send a signal to the 12 side of the 5PV causing the piston rod to instroke to complete the cycle. [6]

(ii) Volume = piston area × stroke compression ratio

$$\text{Volume} = \frac{S \times D^2\pi}{4} + \frac{S \times (D^2 - d^2)\pi}{4}$$

Volume = 16 × 10² × 3.14/4 + 16 × (10² – 2²) × 3.14/4
Volume = 1256 + 1206
Volume = 2462 cm^3 [2]

Volume = piston area × gauge pressure + atmospheric pressure
× no. of cycles

285 litres/min= 2462 × 4 + 1 × ? (number of cycles)
285000 cm^3 = 2462 × 5 × ? (number of cycles)
285000 cm^3 = 12310 × ? (number of cycles)
23 = (number of cycles)

Answer = 23 complete cycles [2]

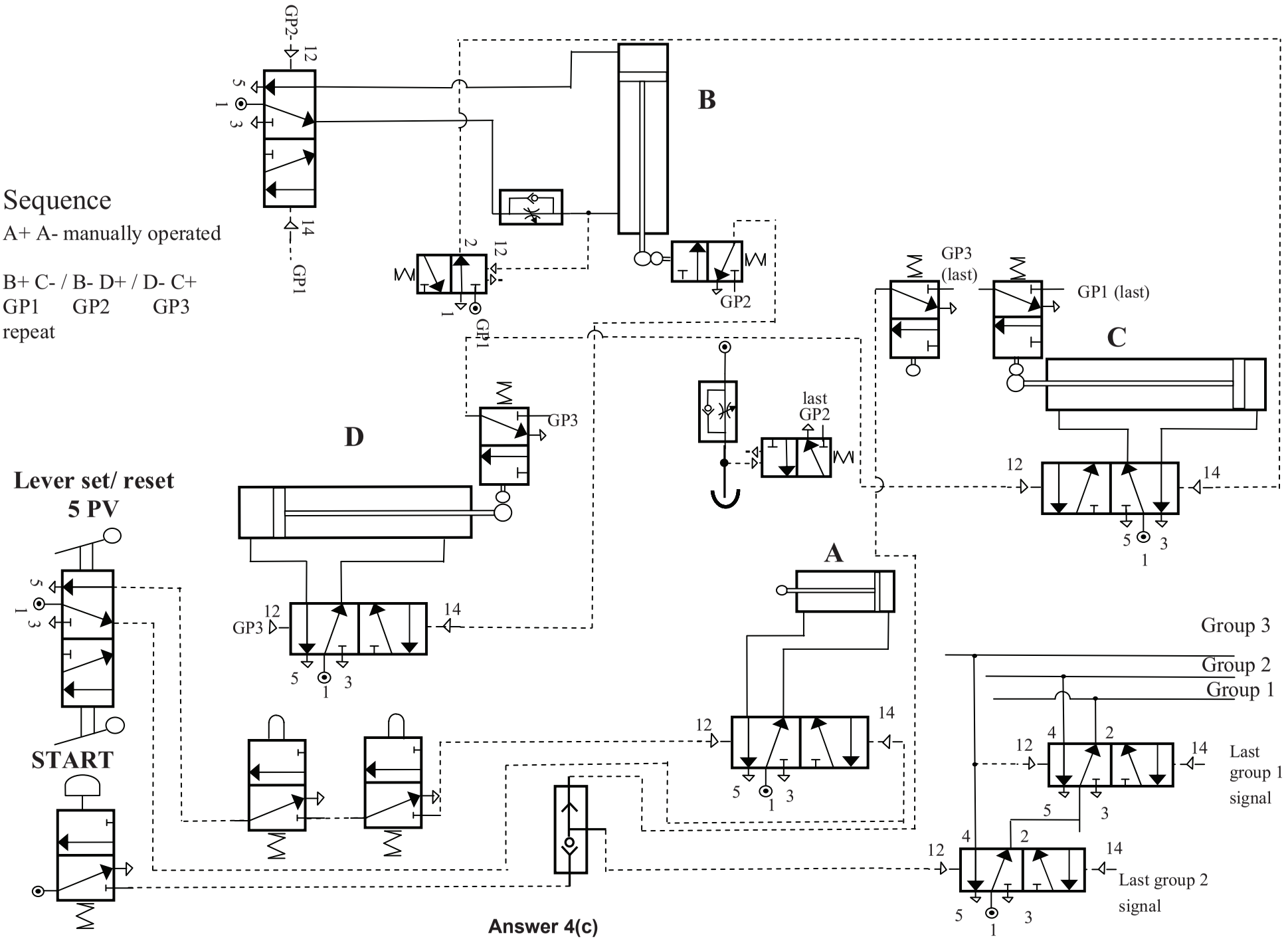
(c) Method of activating cylinder A+ [3]
Method of activating cylinder B+ slowly [2]
Method of activating cylinder C– [2]
Method of activating cylinder B– [1]
Method of activating cylinder D+ air bleed, D– [3]
Method of activating cylinder C+ [1]
Group changeover valves [4]

See sample answer overleaf

Sequence

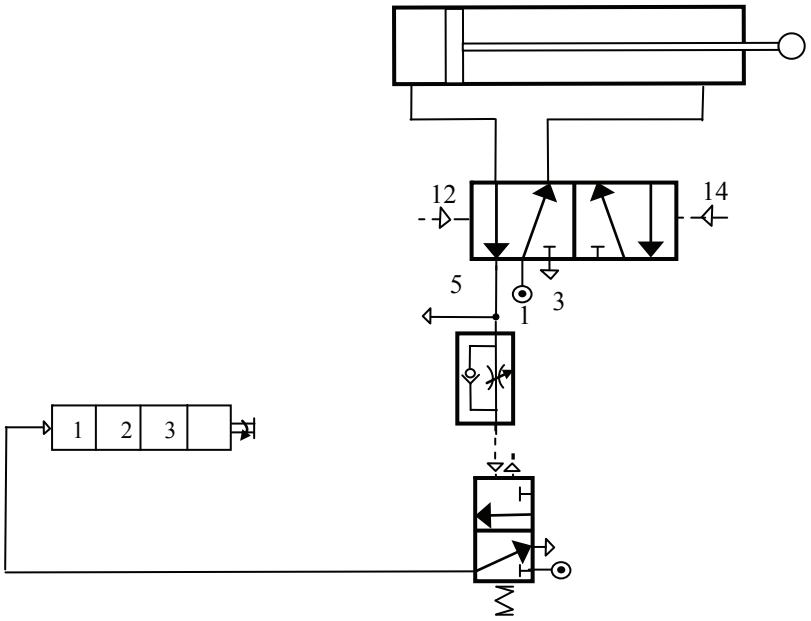
A+ A- manually operated

B+ C- / B- D+ / D- C+
GP1 GP2 GP3
repeat



Answer 4(c)

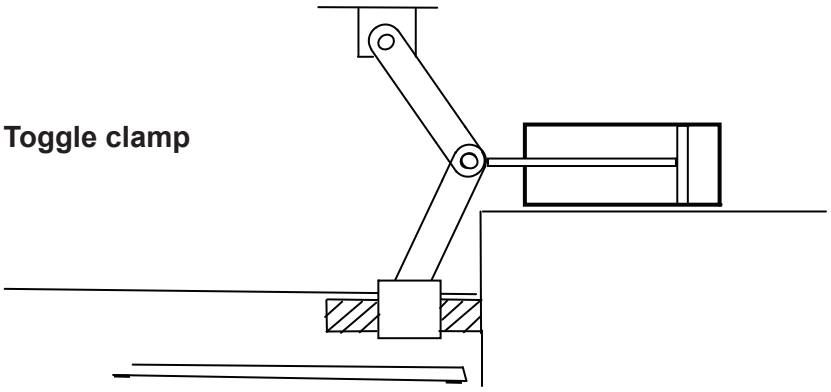
(d) Bullet point 1 – Sample answer



[5]

Bullet point 2 – Sample answer

Toggle clamp



[5]

Section B **80**

Total **80**

AVAILABLE MARKS

40