Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2011

Technology and Design

Assessment Unit AS 1

assessing

Product Design and Systems and Control

[AV111]

THURSDAY 20 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 17-18-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 17-18-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.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

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.

Section A

1 **(i)** Physical properties and mechanical properties.

Mechanical properties refers to how a material reacts when subjected to forces, eg (strength, hardness etc.). Physical properties refers to how a material reacts to forces other than mechanical forces (electrical and thermal conductivity). [2]

(ii) Any **two** factors relating to manufacturing demands from the following:
● Scale of production
● Suitability of manufacturing. [2]

(iii) Any **two** factors relating to the effect of the environment from the following:
● Corrosion resistance
● Stability. [2]

6

2 Wood is supplied in a range of forms.

(i) Any **two** different available forms that wood is supplied in from the following:
● Sheet
● Dowel rod
● Square section planks
● Rectangular section planks
● Various profile forms. [2]

(ii) Any **two** main advantages that plywood has in comparison to chipboard from the following:
● It is much stronger
● It is more suitable for the use of joining fixtures
● Suitable for indoor and outdoor applications. [2]

4

3 **(i)** Any **two** main reasons why vacuum forming is the most suitable from the following:
● Suitable for shallow products made from thin sheet
● Process enables irregular shaped mouldings to be produced
● Relatively cheap process
● Uses only one mould. [2]

(ii) Suitable sketch of the vacuum forming process to include the heater, sheet, mould and vacuum [2]
Description of the clamping, heating, air evacuation and cooling. [2]

6

	AVAILABLE MARKS

4 Adhesives, nuts, bolts and washers may be used to join materials.

   (i) Select from polyvinyl acetate (PVA), solvent cement or epoxy resin the most suitable adhesive for joining each of the following:
   ● Plastic to plastic – Solvent cement
   ● Metal to metal – Epoxy resin
   ● Wood to wood – PVA. [3]

   (ii) Any **two** main reasons why you would select a nut, bolt and washer as a joining method for a particular application from the following:
   ● Temporary method
   ● Strong method
   ● It is not a specialised fitting or fixture
   ● Good availability and range. [2]

5

5 Cell production and just-in-time (JIT) are two systems used to organise manufacturing.

   (i) Any **two** main characteristics of cell production from the following:
   ● Operates as separate units within a large manufacturing plant
   ● Individual cell has responsibility for every aspect of the production of the component
   ● Essential all members of the cell work as a team
   ● Numbers of people in cells can vary. [2]

   (ii) Any **two** main characteristics of just-in-time (JIT) from the following:
   ● Only buy materials and components as and when you need them
   ● JIT removes the need for stockpiles of resources
   ● Saves on money and space. [2]

4

6 (i) QC Any **two** from the following:
   ● QC is part of the achievement of QA
   ● QC involves checks to see if you are meeting these standards, this involves inspecting, sampling and testing. [2]

   (ii) QA Any **two** from the following:
   ● Is about setting standards and meeting them at every stage from design to delivery to customer.
   ● Organisations which meet these standards are awarded the ISO 9000, the international standard of quality. [2]

   mark for clear and coherent explanation using good English grammar. [1]

5

	AVAILABLE MARKS

7 (i) Explain what is meant by the term (CIM).
Computer-integrated manufacture is an interlinked network of
computers controlling machinery and the flow of information during
the entire manufacturing process [2]

(ii) Any **three** main advantages of (CIM) from the following:
- Efficiency
- Ability to track individual components throughout production
- Integrated link between departments
- Cost effective. [3]

5

8 For example. Any **one** main scientific change from the following:
- Developments in materials – lighter and different designs
- Developments in suspension systems – bicycle for alternative sport [2]

Any **one** main fashion change from the following:
- Bicycles for recreation – developments in different sporting activities
- Bicycles used by all ages – developments in different bicycles
- Fashionable to use the bicycle – developments in cycling tourism
  bicycles. [2]

**mark for clear and coherent explanation using good English
grammar.** [1]

5

Section B

9 **(a)** **(i)** Not gate   Or gate   [2]
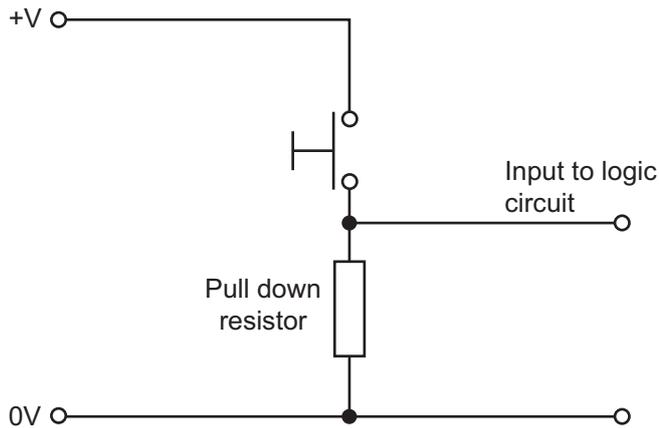
(ii)

A reed switch is activated by proximity to a magnetic field.
Eg. a permanent magnet will cause the contacts in the reed
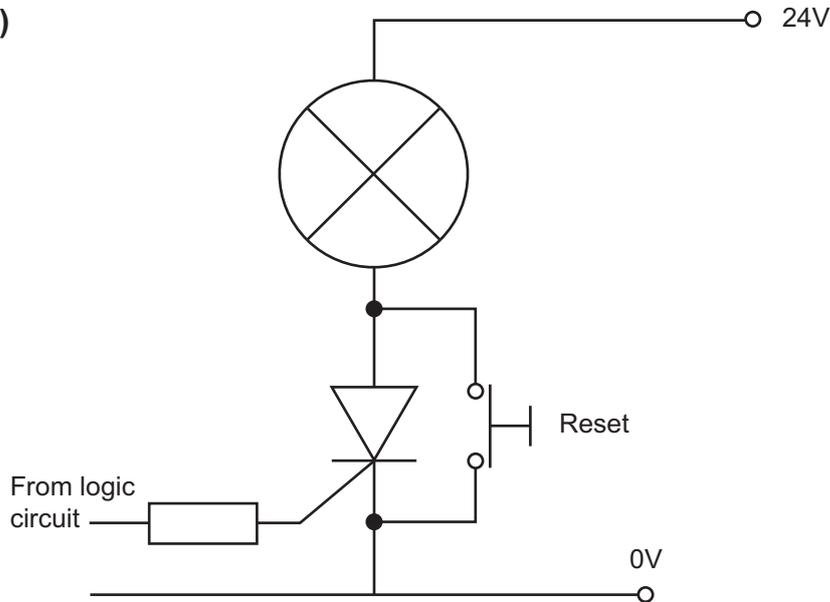switch to close.   [1]
[1]

(iii)

+V

Input to logic
circuit

Pull down
resistor

0V

[3]

(iv) Truth table

A	B	C	Q
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

[4]

(b) (i)

24V

Reset

From logic circuit

0V

[4]

(ii) $\frac{24}{5} = 4.8\,\text{A}.$ $4.8\,\text{A} \times 24\,\text{V} = 115.2\,\text{W}$ [2]

(iii) Heat – Overheating components represent a burn hazard.
Insulation – Inadequate insulation can lead to electric shock
hazard [2]

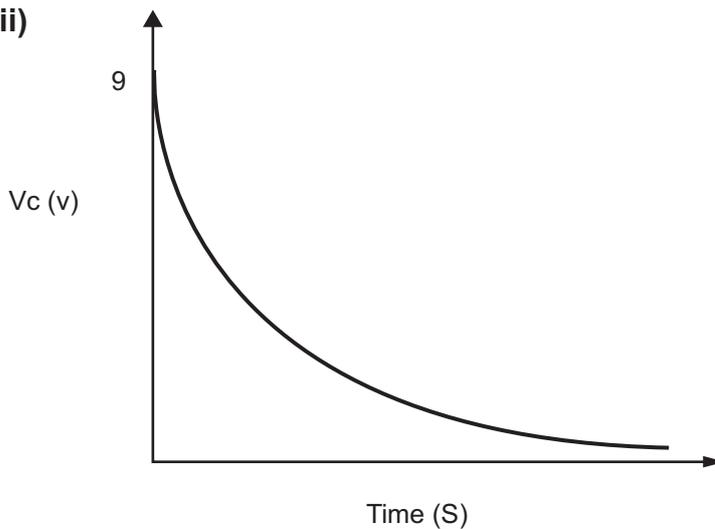Mark for clear and coherent explanation using good English
grammar. QWC [1]

20

10 (a) (i) The time constant is the time taken for the voltage across the
capacitor to reach $\frac{2}{3}$ of the supply voltage. [2]

(ii) 2.2 seconds. [1]

(iii)

9

Vc (v)

Time (S)

[2]

6312.01

7

(b) (i) When Sw1 is closed the capacitor C charges through resistor R. After a time delay, the voltage at the base of the transistor reaches approx 0.6 volts. At this point the transistor collector/emitter junction will conduct causing the LED to illuminate. [4]

Mark for clear and coherent explanation using good English grammar. QWC [1]

(ii) 0.0864 Watts therefore 0.125W or 0.250W would be suitable [3]

(iii) Replace R1 with a variable resistor [1]

(iv) sample answer
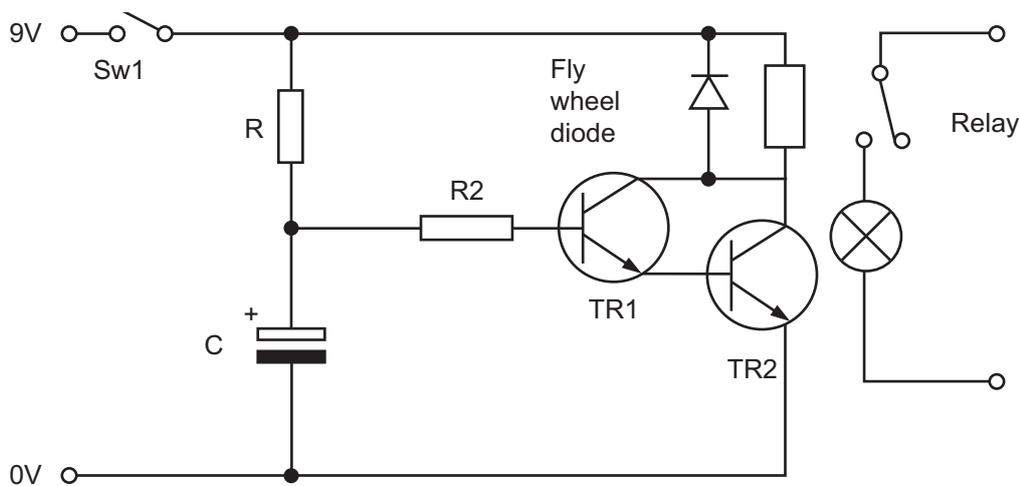
[4]

(v) Darlington pair – any **two** from the following:
- Can have the combination of high gain
- Fast switching time
- Requirement for sensitivity. [2]

20

Section C

11 (a) Fig. 11 shows part of a prototype lifting mechanism.

    (i) Round, vee and toothed belts are commonly used in pulleys.
Name one other belt type.
Ans = Flat   [1]

    (ii) State the direction of rotation of the handle if the load is lowered.
Ans = Clockwise   [1]

    (iii) Calculate the velocity ratio between Gear **A** and Pulley **D**

        Ans = A–B $\frac{80}{20} = 4$ [1]

                C–D $\frac{210}{70} = 3$ [1]

                Tot VR = 4 × 3 = 12   [1]

    (iv) Calculate the transmission speed at sprocket **F** if the handle is
rotated at 30 rev/min.

        Ans = **VR** A–B = 4

                C–D = 3   [1]

                E–F = $\frac{20}{30} = \frac{2}{3}$ [1]

                $4 \times 3 \times \frac{2}{3} = 8$ [1]

                OS = IS/VR

                OS = $\frac{30}{8}$

                3.75 rev/min   [1]

    (v) The components in lifting mechanism are changed to produce a
velocity ratio of 40. Calculate the effort required at the handle if
the efficiency of the overall lifting mechanism is 80%. Frictional
effects should be neglected.

        Ans = Eff = MA/VR

                $80 = \frac{?}{40}$

                MA = 32   [2]

                MA = L/E

                $32 = \frac{160}{?}$

                E = 5   [2]

(vi) Using an annotated sketch outline how a cotter pin may be used to fix the handle to the shaft.
Ans = Suitable annotated sketch of cotter pin in shaft. [2]

(vii) Briefly explain how the mechanical advantage of the lifting mechanism could be improved without modifying the gear, pulley or sprocket systems.
Ans = Extend the length of the handle. Increasing the distance from the end of the handle to the pivot point. [1]

(b) Following testing a jockey wheel is added to the pulley in the lifting mechanism. Discuss why jockey wheels are used and outline the main differences between fixed and self aligning jockey wheels.
Ans = Discussion stating the following points:
- Fixed system will require frequent checking as the effect diminishes as the pulley becomes worn. It will need to be reset manually.
- The self aligning system automatically takes up any slack using the force exerted by the spring. [3]

Mark for clear and coherent explanation using good English grammar.
QWC [1]

20

12 **Fig. 12** shows an incomplete pneumatic circuit to be used to open and close an air outlet.

(a) Name the following activation methods shown on **Fig. 12**:

(i) Activation method at **X**.
Ans = Solenoid [1]

(ii) Activation method at **U**.
Ans = Pilot/Signal Air [1]

(iii) During operation the following problem was detected.
Cylinder **A** was found to outstroke in a sluggish manner. Describe why this may happen and how it would be resolved.
Ans = A suitable explanation is likely to contain the following points:
- The air is being restricted going into the double acting cylinder causing sluggish action.
- One option would involve placing the flow restrictor on the air line coming out of the cylinder [2]

Mark for clear and coherent explanation using good English grammar.
QWC [1]

	AVAILABLE MARKS

(iv) On the proforma provided (Answer No 12 (iv), (v), (vi) and (vii)) complete the circuit enabling the three port valve **W** to be operated using an air bleed.

Ans = (See sample answer)

FCV

Diaphragm [1]

Tee connection

Piping [1]

(v) On the proforma provided (Answer No 12 (iv), (v), (vi) and (vii)) complete the circuit to enable cylinder **A** to instroke automatically following an outstroke.

Ans = (See sample answer)

3 PV including positioning [2]

Piping [1]

(vi) On the proforma provided (Answer No 12 (iv), (v), (vi) and (vii)) complete the circuit to enable cylinder **A** to outstroke when either three port valves **V**,**W** or **X** are activated.

Ans = (See sample answer)

OR connection between V, W and X [1]

Shuttle valves [1]

Piping [1]

Piping to printed shuttle valve [1]

(vii) On the proforma provided (answer number 12 (iv), (v), (vi) and (vii)) add a 3 PV which performs a **NOT** logic function to prevent cylinder **A** from activating.

Ans = (See sample answer)

Three port valve [1]

Method of activation [1]

Positioning in circuit [1]

(b) The double acting cylinder **A** is supplied with an air pressure of $0.4\,N/mm^2$, has a piston diameter of 50 mm and a piston rod diameter of 8 mm. Calculate the force produced by the cylinder during the instroke. Please assume $\pi = 3.14$.

Ans = (See sample answer)

$25 \times 25 \times 3.14 = 1962.5$ [1]

$4 \times 4 \times 3.14 = 50.24$ [1]

$1962.5 - 50.24 = 1912.26$

$1912.26 \times 0.4 = 764.9\,N$ [1] | 20

Total | **80**

Answer No 12

Air Outlet

V

W

X

A

12

5

1 2

3

4

14

U