1145-530 JUNE 2017 Marking Scheme

Question 1

a)   The ability of a material to be shaped or moulded.

(1 mark)

b)   The ratio of the density of a substance to the density of a reference substance.

(1 mark)

AO1, 301: 1.1

Question 2

One mark for **each** cell completed with accurate information.   **(4 marks)**

E.g. materials could include any named polymer, ceramic or composite and typical application.

AO1, 301: 1.2

Question 3

Allow for 5% variation in the answers due to graph reading; also allow any value in the elastic zone to be used for calculating stress and strain – this should not affect the final answer.

Stress = load / CSA
= 72 / 78.55 = 0.92 kN mm^{-2} Award 1 mark for method for stress and 1 mark for value   **(2 marks)**

Strain = extension / original length
= 1.5 / 90 = 0.017   Award 1 mark for method for strain and 1 mark for value   **(2 marks)**

Therefore Young's modulus = 0.92 / 0.017
= 54 kN mm^{-2} Award 1 mark for value

(1 mark)

Accept answer when presented as: 5.4 x 10^{10} Pa (or 54 GPa).
Allow for 5% variation in the answers due to graph reading.

(Total for question 5 marks)
AO2, 301: 3.3

Question 4

Award one mark for any of the following points, **up to** four in total:

- A template is used to mark out the material.

- The pre-preg material is cut to the required shape.

- A release film is applied to the mould.

- The pre-preg material is placed in the mould.

- Heat and pressure is applied using either a vacuum bag and oven OR an autoclave.

- Any other appropriate response.

(4 marks)
AO1, 301: 4.2

Question 5

a) When the magnetic flux linking a circuit changes, an electromotive force is induced in the circuit proportional to the rate of change of the flux linkage. **(1 mark)**

AO1, 302: 1.4

b) Award one mark **each** for gate plug, light curtain and safety mat.

Allow any other appropriate response. **(3 marks)**

AO1, 302: 5.2

c) Control that is proportional to the integral to the error with respect to time. **(1 mark)**

AO1, 302: 4.7

d) Award one mark for **each** of the following points, up to a **maximum** of 4 marks:

- They can be used when the input of a measurement system is the current value of an information variable.
- They can be used when the output of a measurement system is proportional to the measured value of the variable.
- They can be used when the measured value is required to equal the true value.
- Where greater accuracy of the system is required, it is necessary to reduce the difference between the current value and the true value.
- Any other appropriate response.

(4 marks)

AO2, 302: 4.1

e) Award one mark for each of the following points up to a maximum of six marks:

- The magnitude of the sensor current (1) may exceed the rating of the controller (1), resulting in component failure (1).
- Current consumption (1); the controller may require a certain level of current in order to function (1).
- Fluctuations in the current may damage the controller (1), requiring transient protection (1).

(6 marks)

AO2, 302: 5.3

Question 6

a) Award 1 mark for **each** of the following lines:

Angular speed $= 2\pi f$
$\qquad = 2 \times 3.14 \times 8 = 50.24$ revolutions second^{-1}.
Centripetal acceleration $\qquad = \omega^2 \times r$
$\qquad = 50.24^2 \times 0.2 = 504.8$ m s^{-2} (accept 505 m s^{-2})

(4 marks)

AO2, 303: 3.3

b)   Award 1 mark for **each** of the following lines:

PV=nRT
As nRT is constant $P_1V_1 = P_2V_2$
Rearranging $P_2 = P_1V_1 / V_2$
$P_2 = 2 \times 1000 / 800$ bar = 2.5 bar

Accept alternative methods.

(4 marks)

AO2, 303: 4.2

Question 7

a)   The total energy of an isolated system is constant / energy can be transformed from one form to another, but cannot be created or destroyed.

(1 mark)

AO1, 303: 4.1

b)

i)   The friction that exists between a stationary object and the surface on which it is resting.   **(1 mark)**

AO1, 303: 3.6

ii)   Oscillating motion where a restoring force is applied that is proportional to, and in the opposite direction of that displacement.   **(1 mark)**

AO1, 303: 3.4

Question 8

a)   Award one mark **each, up to** a total of two marks, for injection, vacuum, blow, transfer and thermoforming.   **(2 marks)**

AO1, 304: 3.3

b)   Award one mark **each** for **up to** four of the following:

- They help to ensure repeatability (1) and consistency (1) within the batch – these are not an issue for a one-off product (1).

- Increased speed of marking out or production (1) for the total batch exceeds the time needed to make the jig /template when manufacturing a batch (1).

- The cost per product of a jig or template for a one-off would be much higher than that for a batch, where it can be divided between all the manufactured products (1).

- Any other suitable reason.

(4 marks)

AO2, 304: 2.1

Question 9

a) Award one mark **each** for the following points up to a **maximum** of three marks:

- Selection of output device.
- Setting of paper size.
- Selection of paper orientation.
- Selection of paper source/tray.
- Configuration of printer/plotter settings.

(3 marks)
AO1, 305: 6.2

b) One mark for **each** of the following points **up to** a total of five marks:

- Different stakeholders have different requirements.
- Customers may want low cost, but manufacturers want to make the highest possible profit.
- Regulators may have requirements that the product must meet, which could have cost, safety and functional implications.
- Functional requirements may be influenced by manufacturing capabilities.
- The choice of materials may be limited by cost considerations (1); this may also limit the functional properties of the product (1).
- Any other suitable point, including suitable examples of design conflicts.

(5 marks)
AO2, 305: 2.2

c) Indicative content
   Examples of points that may be included in the answer are:
   - Development of new job roles: manufacturing, maintenance and repair, content production.
   - Development of markets for new products by advertising (creation of market need); creation of fashion and trends.
   - Social pressure to own television/radios or access premium services, resulting in economic pressures.
   - Impact of media on accepted norms of behaviour.
   - Increased awareness of global events and political issues, facilitating social pressure for action.
   - Impact on leisure time activities, with potential secondary effects on health.
   - Use to facilitate training and increase education.
   - Influence of communication methods on ability to respond in emergency situations.

Band descriptors
Award marks as follows:

No answer worthy of credit – e.g. insufficient work submitted, answer not relevant to the question, answer is factually incorrect.

(0 marks)

Band 1 – basic – largely descriptive response based on recall of knowledge. A few impacts, either mainly social or mainly economic, are stated but their implications are not explained. Candidates at the top of this level may be characterised by describing some impacts more in detail, but showing understanding of why only one of the impacts has resulted.

(1-3 marks)

Band 2 – clear – more detailed response, including statements of impacts that show understanding of most of their direct implications. Both social and economic impacts discussed with some evaluation. Candidates at the top of this level may be characterised by stating and explaining a variety of impacts or causal links contributing to or resulting from impacts; they may evaluate the broader implications to society of a few of these impacts.

(4-6 marks)

Band 3 – detailed – very detailed response including statements of impacts that show understanding of both their direct and secondary implications. Both social and economic impacts discussed, with linking and conclusions drawn. Candidates at the top of this level may be characterised by evaluating and substantiating how a broad range of impacts or causal links have affected society both directly and through secondary effects.

(7-9 marks)
AO4: Synoptic

Question 10

a) Award 1 mark for method and 1 mark for correct value:

Safety factor = design load / maximum load = 108 / 18 = 6

(2 marks)
AO2, 306: 5.7

b) For ii) and iii) allow tolerance of ± 2 for reading the graph.

    i)   Award 1 mark for method and 1 mark for answer:

Mean value = ((1x5)+(5x15)+(12x25)+(12x35)+(14X45)+(6x55))/50
Mean value = 35.2 hours

(2 marks)
AO2, 306: 5.6

    ii)   From the graph, median value is approximately 36 hours

(1 mark)
AO2, 306: 5.6

    iii)   Award 1 mark for each line below:

20% failure equates to 10 (out of the 50) components

From the graph, the operational tool life is therefore 23 hours.

(2 marks)

AO2, 306: 5.6

Question 11

a)   Award 1 mark for the method and 1 mark for the answer:

Tan C   = Sin C / Cos C

= 0.8 / 0.6 = 1.33   **(2 marks)**

AO2, 306: 2.1

b)   Award 1 mark for the method and 1 mark for the answer:

4/3 π radians = 4/3 x 180 = 240 degrees   **(2 marks)**

AO2, 306: 2.2

c)   Award 1 mark for method for x, 1 mark for method for y, and 1 mark each for correct values:

$x = r \cos \theta = 110 \cos -35° = 90.1$

$y = r \sin \theta = 110 \sin -35° = -63.1$ (negative symbol must be shown to award mark for value)

(4 marks)

AO2, 306: 4.4

Question 12

a)   Award 1 mark for each line below:

Let $u = 2x - 4$ and $y = u^6$

$du/dx = 2$

$dy/du = 6u^5$

hence $dy/dx = 6u^5 \times 2 = 12(2x-4)^5$

Accept alternative working out, and award full marks if final answer is correct.

(4 marks)

AO2, 306: 3.1

b)   Award 1 mark for each line below:

First term of the polynomial must be 5x; multiplying by (x+1) gives $5x^2 + 5x$

The remainder is found by subtracting: $5x^2 + 4x - 6 - 5x^2 + 5x = -x -6$

The second term in the polynomial must be -1; multiplying by (x+1) gives $-x - 1$

The remainder is found by subtracting: -x -6 - -x-1 =-5

Hence the result of the division is 5x – 1 remainder -5   **(5 marks)**

AO2, 306: 1.4

Question 13

Indicative content

Examples of points that may be included in the answer are:

- Performance requirements.

- Characteristics of the user.

- Material types and properties, such as strength, toughness, density, corrosion resistance etc.

- Material cost (direct and manufacturing).

- Selling price.

- Strength to weight ratio.

- Impact of relevant standards.

- Aesthetic requirements of the customer.

- Quantity required and influence of the scale of manufacture.

- Consideration of process capabilities and manufacturing tolerances.

- Manufacturing limitations and constraints.

- Integration of electronic devices.

- Sections shapes and available material forms.

Band descriptors

Award marks as follows:

No answer worthy of credit – e.g. insufficient work submitted, answer not relevant to the question, answer is factually incorrect.

(0 marks)

Band 1 – basic – largely descriptive response based on recall of knowledge, stating a few factors to be considered during the selection of the material. May describe some factors in detail. Candidates at the top of this level may be characterised by showing understanding of the reasons for a few of the considerations.

(1-4 marks)

Band 2 – clear – more detailed response, including a range of different factors to be considered when selecting the material. Shows recall of knowledge and understanding of the reasons why many of the factors have to be considered. A few considerations are analysed, with ranking as to their relative importance. Candidates at the top of this level may be characterised by evidence that they have considered how a broad range of factors, such as customer preference, material properties and manufacturing implications will affect the performance of the product.

(5-8 marks)

Band 3 – detailed – very detailed response, showing understanding of a wide variety of different factors have to be considered when selecting the material. Most factors to be considered are evaluated, with substantiation of which are deemed more important, making recommendations and producing supporting conclusions. Candidates at the top of this level may be characterised by analysing and evaluating a broad range of considerations some of which include conflicting requirements.

(9-12 marks)
AO4, Synoptic