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Design & Technology
Eduqas GCSE

Systems: forces, stresses, reinforcing and stiffening

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don’t spend too much time on one question

Good luck!

Q1. Which force is a twisting force?

A Tension

B Torsion

C Shear

Q2. Bending is a combination of which two forces?

A Tension and compression

B Torsion and shear

C Shear and torsion

Q3. Why are ribs and webs moulded into plastic parts?

A To stiffen them without adding much weight

B To reduce friction

C To conduct heat away

Q4. What does a conformal coating (lacquer) do?

A Gives the casing grip

B Protects the PCB from moisture and corrosion

C Stops components overheating

Q5. What stops wires being pulled out of a circuit?

A A heat sink

B A rubber gasket

C Strain relief on the cable

Q6. Why is glass fibre filled nylon used for gears in printers?

A It conducts electricity

B It is transparent

C It is stronger and stiffer

Q7. The main body of a desk lamp is cut from a single piece of white acrylic. Its two side pieces are bent outwards into curves and placed into the top part, which holds them in shape. State the type of force the top part is subjected to from the two side pieces of the main body. **(1 mark)**

Q8. A wooden beam is supported at one end only, where it is built into the wall of a building. Describe the effect on the beam when a load is applied at its free end. **(2 marks)**

Q9. A crane lifts heavy loads using steel cables. Components of the crane will be affected by compression, tension and torsion. Give one example of where each of these forces occurs when the crane is operating. **(3 marks)**

Q10. State the rotational force that is applied to the body of a bolt when a spanner is used to tighten it. **(1 mark)**

Q11. A right-angled joint in a timber building frame is secured with hardwood dowels that pass through both pieces. A downward force is applied to the horizontal piece. Name the force that will act on the dowels. **(1 mark)**

Q12. A child's ride-on buggy has a siren and lighting unit that fits to the handlebars. The casing is injection moulded from acrylonitrile butadiene styrene (ABS). The inside of the casing has thin strips of plastic moulded across it to strengthen it.

Q12a. Name the specific technique that has been used to strengthen the casing. **(1 mark)**

Q12b. Explain two working properties of ABS that make it an ideal material for the casing. **(4 marks)**

Q13. A shaft in a machine is supported by bearings. Explain why bearings are needed to support a shaft in a machine. **(2 marks)**

Q14. This question is about friction in mechanisms.

Q14a. Give one reason for lubricating steel spur gears in a mechanism. **(1 mark)**

Q14b. Give one result of not lubricating a mechanism running at high speed. **(1 mark)**

Q14c. Oil or grease can be used to reduce friction in a moving joint. Give two benefits of reducing friction in a mechanism. **(2 marks)**

Q15. A teaching aid for schools has a case made from polymers. The circuit board is screwed to the inside of the case. Explain two physical characteristics of polymers that make them an ideal material from which to make the case of the teaching aid. **(4 marks)**

Q16. A solar powered garden light has a lens made from acrylic, which covers the electronic components. Give two different properties of acrylic that make it an appropriate choice of material for the lens. For each property, explain one advantage of using acrylic for the lens. **(6 marks)**

Q17. A printed circuit board (PCB) has a terminal block for connecting the power leads. The power leads need strain relief to stop them pulling out. Use sketches and notes to show a method of strain relief for the power leads. **(3 marks)**

Answers

Q1. B
Q2. A
Q3. A
Q4. B
Q5. C
Q6. C

Q7.

Compression (1).

Q8.

1 mark for each valid point. Allow 2 marks for a point that is fully explained:

- The beam will bend
- Tension on the top face of the beam
- Compression on the bottom face of the beam

Q9.

Any three points (1 mark each). Allow 2 marks for a single point fully explained. For example:

- Compression: in the vertical parts of the crane structure, from the load being lifted and the weight of the crane itself; or in the extended legs
- Tension: in the cables carrying out the lift
- Torsion: in the tower when the crane turns while carrying a load, or when the wind blows on the jib

Q10.

Torque (1). Allow torsion.

Q11.

Shear (1).

Q12a.

Ribbing or ribs (1).

Q12b.

Two working properties (1 mark each), each with a linked justification (1 mark each). For example:

- ABS has good plasticity when heated (1), so it can be forced to flow into the mould to make the casing (1)
- ABS has good thermal stability (1), so the casing will not soften or deform at high temperatures (1)
- ABS has good impact resistance (1), so there is little risk of it cracking or breaking even if dropped by a child (1)

Q13.

2 marks for two points, or for one point described in depth. For example:

- To reduce friction in the moving parts
- To allow a film of oil or grease to separate the surfaces of the parts
- To prevent wear in the shaft, or in the body of the machine
- Bearings can be replaced when worn

Q14a.

Any one (1): reduces wear in the gears; reduces friction and heat build-up; smoother running.

Q14b.

Any one (1): gear teeth damaged or could melt; excessive noise from the gears; the mechanism sticks or breaks down. Allow increased wear on parts.

Q14c.

Any two (1 mark each): reduced wear on parts, so the mechanism lasts longer; reduced sound; reduced heat in the mechanism; increased efficiency.

Q15.

Two physical characteristics (1 mark each), each with a linked justification (1 mark each). For example:

- Polymers are electrical insulators (1), so they will not conduct electricity, which makes the case safe (1)
- Polymers are tough (1), so the product can be dropped or knocked without being damaged (1)
- Polymers are waterproof (1), so they will not be damaged by water (1)

Q16.

Two properties (1 mark each), each with two linked justifications (1) + (1). Do not accept repeated justifications. For example:

- Good electrical insulator (1), so it will not conduct electricity (1), so there will be no short circuits (1)
- Tough, durable or impact resistant (1), so it can withstand knocks and bumps (1), so it lasts a long time in the garden (1)
- Transparent or semi-transparent (1), so it lets light through (1) to light the garden well (1)
- Waterproof (1), so it will not be affected by rain (1), so it lasts a long time and protects the components below the lens (1)

Q17.

One mark for each:

- Wires shown secured into the terminal block (1)
- A securing method, e.g. a small clamp, or two holes in the board to thread the wires through (1)
- No damage caused to the track areas of the PCB (1)