General Certificate of Secondary Education

A514/03

Design and Technology:
Electronics and Control Systems:
Mechanisms

Unit A514: Technical aspects of designing and making

Specimen Paper

Time: 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:

Candidate Forename		Candidate Surname	

Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do not write in the bar codes.
- Do not write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The Quality of your Written Communication is assessed in questions marked with an asterisk (*).
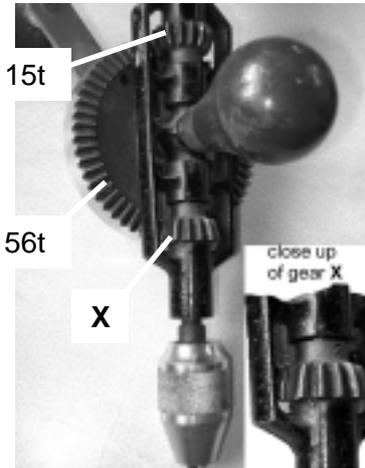- The total number of marks for this paper is 60.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This document consists of **16** printed pages.

Section A

Answer **all** questions.

1 Fig. 1 shows a range of hand tools which include the use of mechanisms.

15t

56t

X

close up
of gear **X**

hand drill

G cramps

brace

Fig. 1

(a) (i) State the type of gear used at point **X** in the hand drill.

.... **[1]**

 [1]

(ii) Calculate the gear ratio of the drill mechanism.

Use the formula gear ratio = driven / driver.

.... **[2]**

(iii) If the handle of the hand drill is rotated at 50 RPM calculate the rotation speed of the drill bit.

....

.... **[2]**

(b) The brace shown in Fig. 2 uses a crank to apply turning effort to the drill bit.

    (i) Using the information shown in Fig. 2 give the class of lever that is used in the brace.
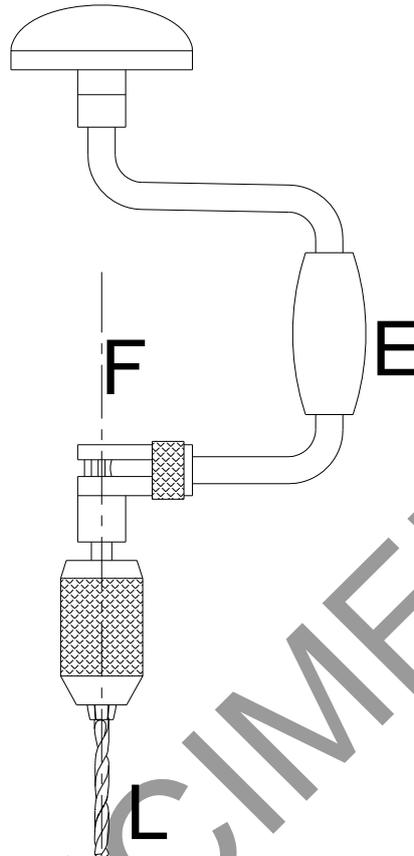

Fig. 2

…… **[1]**

    (ii) Give **one** method of increasing the torque of the brace.

…… **[1]**

[Turn over

(c)* Two G cramps are shown in Fig. 4 with enlarged views of the thread and pressure pad of each.

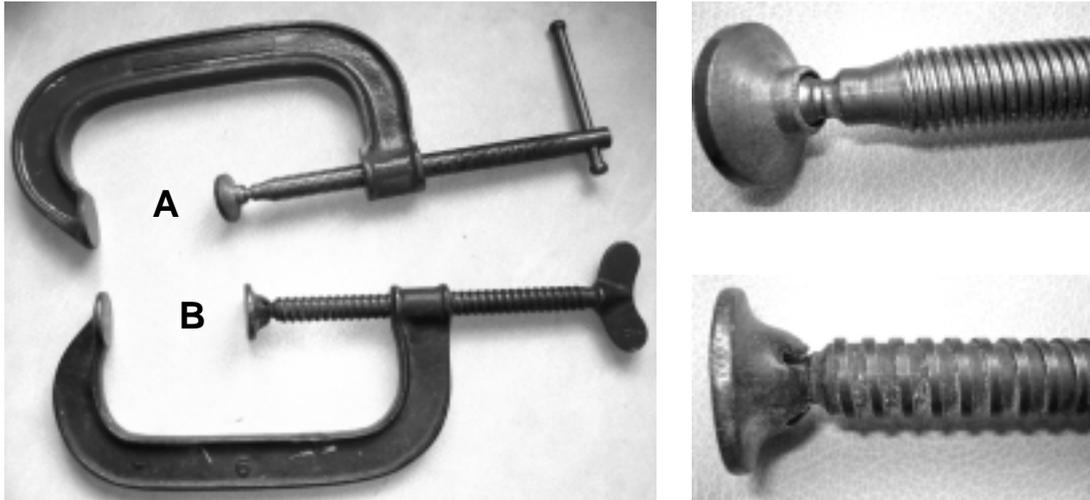**Fig. 4**

Evaluate why cramp **A** is capable of applying greater force than cramp **B**.

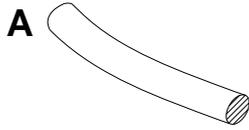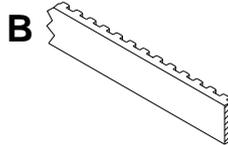...

....

....

....

....

....

....

.... **[5]**

[Total: 12]

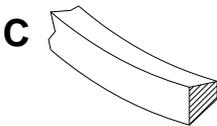**2** **(a)** Mechanisms often include the drive systems shown in Fig. 5.

    (i) Name each drive system.

A

A .... **[1]**

B

B .... **[1]**

C

C .... **[1]**

D

D .... **[1]**
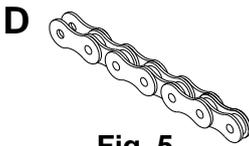
    Fig. 5

SPECIMEN

    (ii) Give **one** benefit of drive system **B** when compared to drive system **A.**

       ....

       .... **[1]**

[Turn over

(b) Fig. 6 shows drive system **C** being used to take the drive from a motor to a machine shaft.

stepped pulley

motor shaft

machine shaft

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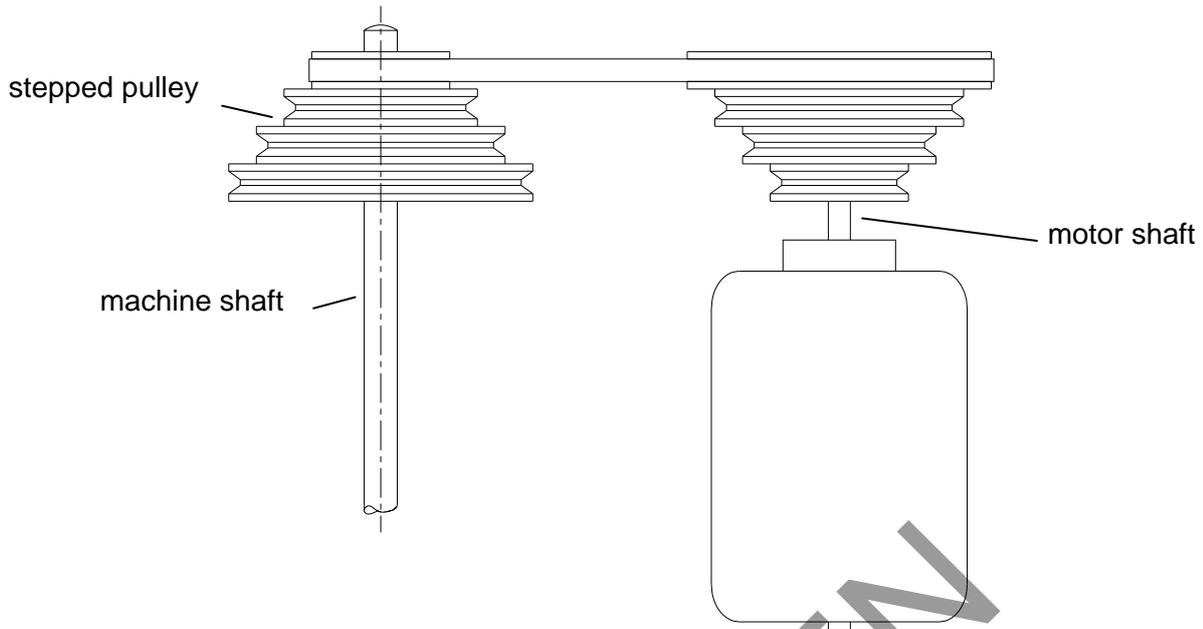**Fig. 6**

(i) Describe the speed of the machine shaft when compared to the motor shaft with the belt in the position shown.

.... **[1]**

(ii) Use notes and sketches to show how the stepped pulley in Fig. 6 could be fixed to the machine shaft.
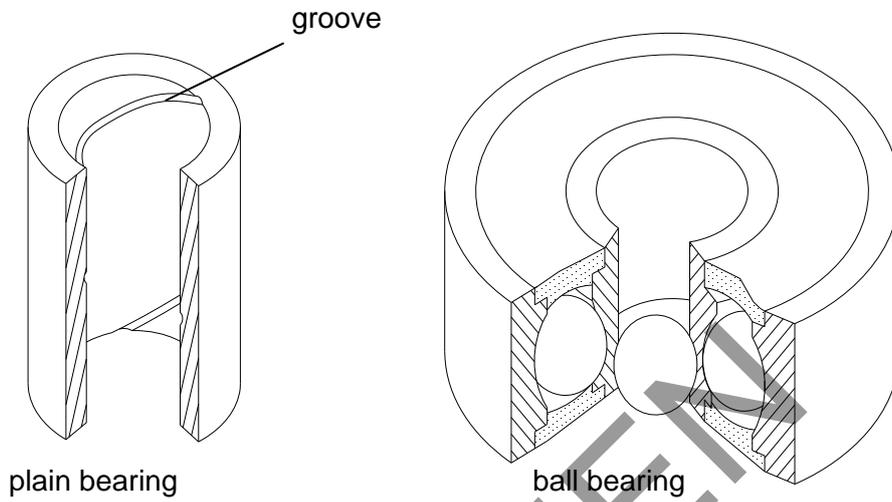
The stepped pulley should be removable to allow for maintenance.

[3]

7

(c) Two types of bearing are shown in Fig. 7.

Either type could be used on a machine shaft.

(i) Explain why the ball bearing would normally be chosen in preference to the plain bearing.

Fig. 7

plain bearing   ball bearing

....

....

.... **[2]**

(ii) State the purpose of the groove shown on the plain bearing.

....

.... **[1]**

[Total 12]

3 Fig. 8 shows the drive of a mountain bike.

7 sprockets on rear wheel

derailleur gear

gear cable
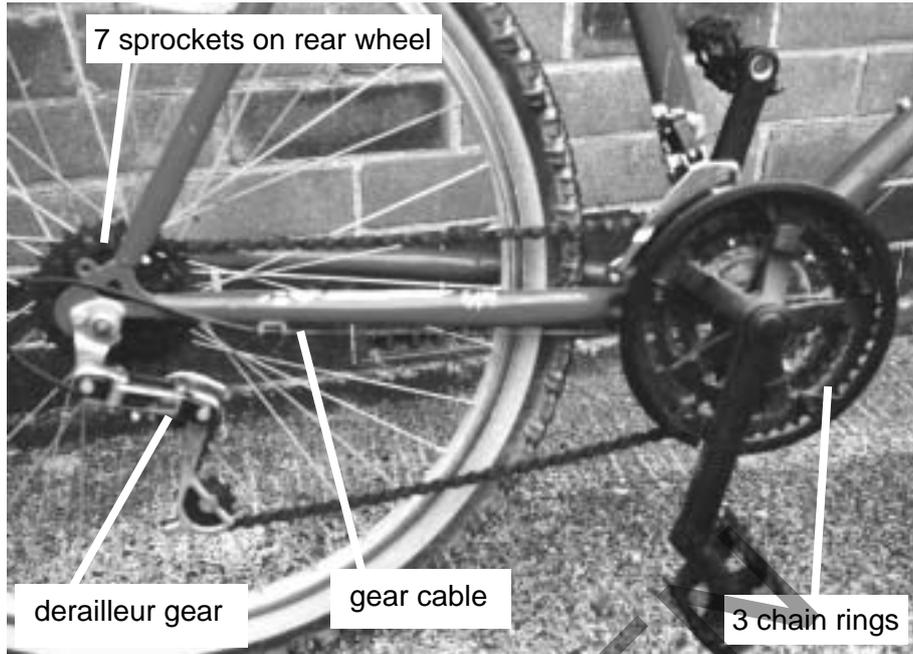
3 chain rings

Fig. 8

(a) (i) State the number of gears that can be selected on the mountain bike.

.... **[1]**

(ii) The circumference of the wheel is 2075mm.

Calculate the distance travelled by the bike for **one** complete revolution of the crank if a 49t chain ring and a 16t rear gear are in use.

....

....

.... **[3]**

(iii) Give **two** functions of the derailleur gear mechanism.

1 .... **[1]**

2 .... **[1]**

(b) The gear cable is made from twisted steel wire.

Give **two** properties that will be required from the cable.

1... **[1]**

2... **[1]**

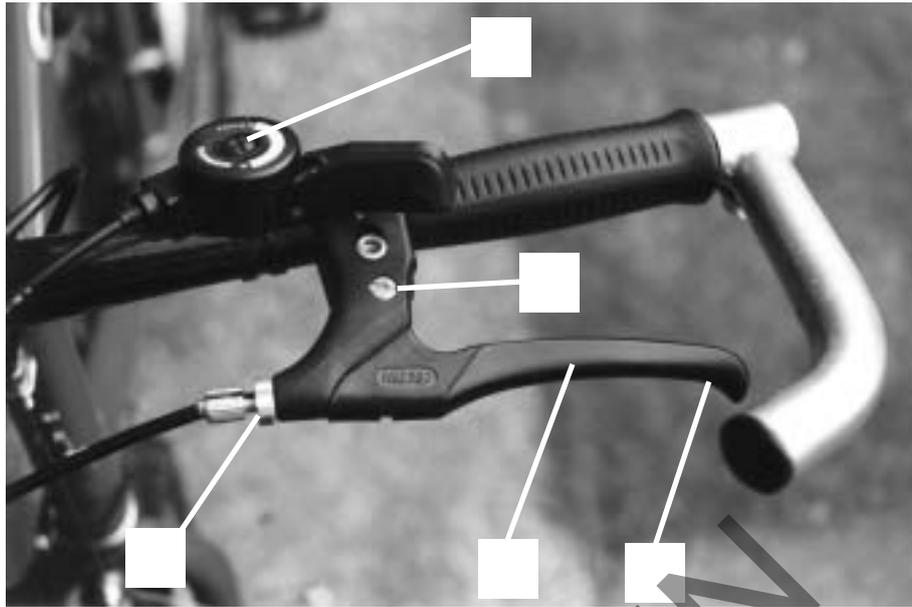**(c)** A brake lever from the bike is shown in Fig. 9.

Fig. 9

(i) Mark **F** for fulcrum in the box on Fig. 9 which is pointing to the fulcrum of the brake lever. **[1]**

(ii) Mark **L** for lever in the position on the lever that will provide the maximum gain in force when the lever is operated. **[1]**

(d) Two types of mountain bike brake are shown in Fig. 10.

centre pull brake   disc brake

Fig. 10

Explain why the disc brake is a more efficient braking system.

....

....

.... **[2]**

[Total: 12]

Section A Total [36]

[Turn over

Section B

Answer **all** questions

4   A test rig is required to test wear on fabric. Fig. 11 shows part of the rig.

The pressure pad can move backwards and forwards and slides into position in the T slots.
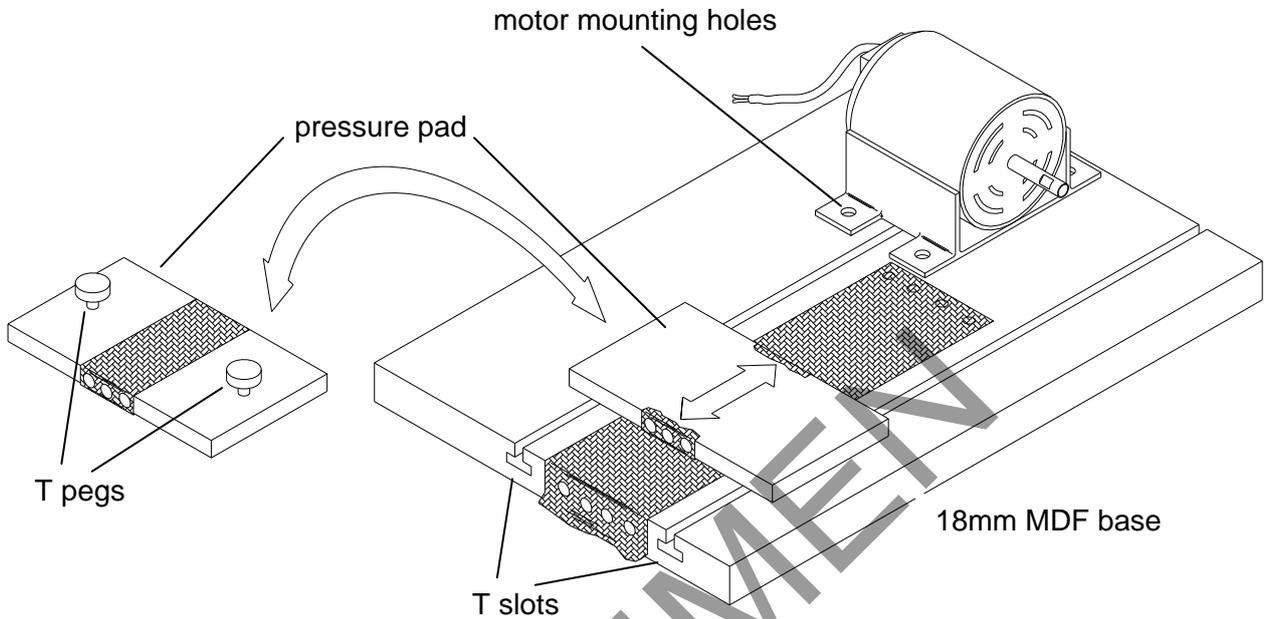
Fig. 11

(a)   Use notes and sketches to show a method of securing the motor to the 18mm MDF base.

The method used must ensure that the motor cannot vibrate loose.

[3]

(b)   A mechanism is needed to move the pressure pad 25mm backwards and 25mm forwards across the fabric being tested.

(i)   State the name of a mechanism that will convert rotary motion to reciprocating motion.

.... **[1]**

(ii) The motor shaft is Ø10 with a flat machined on the end of it.

Use notes and sketches to show a suitable mechanism to be attached to the motor that will provide a total horizontal movement of 50mm.

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[5]

(iii) Use sketches to show how your mechanism is attached to the motor.

[2]

[Turn over

(c) Friction between the two pegs and the slots should be kept to a minimum.

Give the name of a suitable material for the two pegs that will reduce friction in the movement of the pressure pad.

.... **[1]**

[Total: 12]

5 A student is designing a mechanical toy that will use a cam to make the outline of a bird rise and fall as a handle is rotated.

(a) On the three outlines shown in Fig. 12 draw the following cam outlines:

- **one** smooth rise and fall with **continuous** movement;

- **one** smooth rise and **rapid** fall for each rotation;

- **two irregular** rise and fall movements.
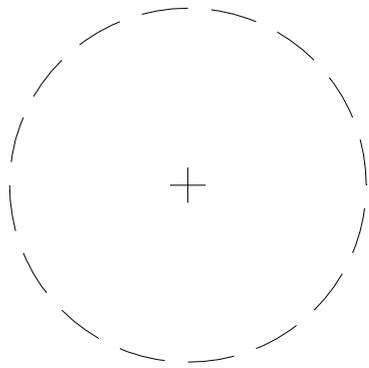
smooth rise and fall **[1]**
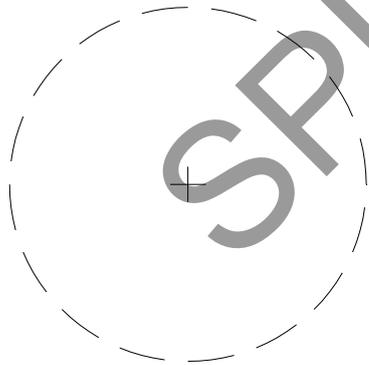
smooth rise and rapid fall **[1]**
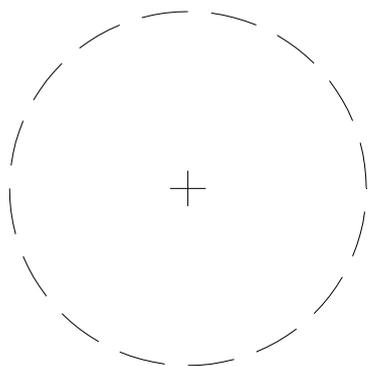
two irregular rise and falls **[1]**

Fig. 12

[Turn over

(b) The outline of a framework that will hold the cam is shown in Fig. 13.

The top has been cut away to show the cam in position with a hole indicated for the cam follower.
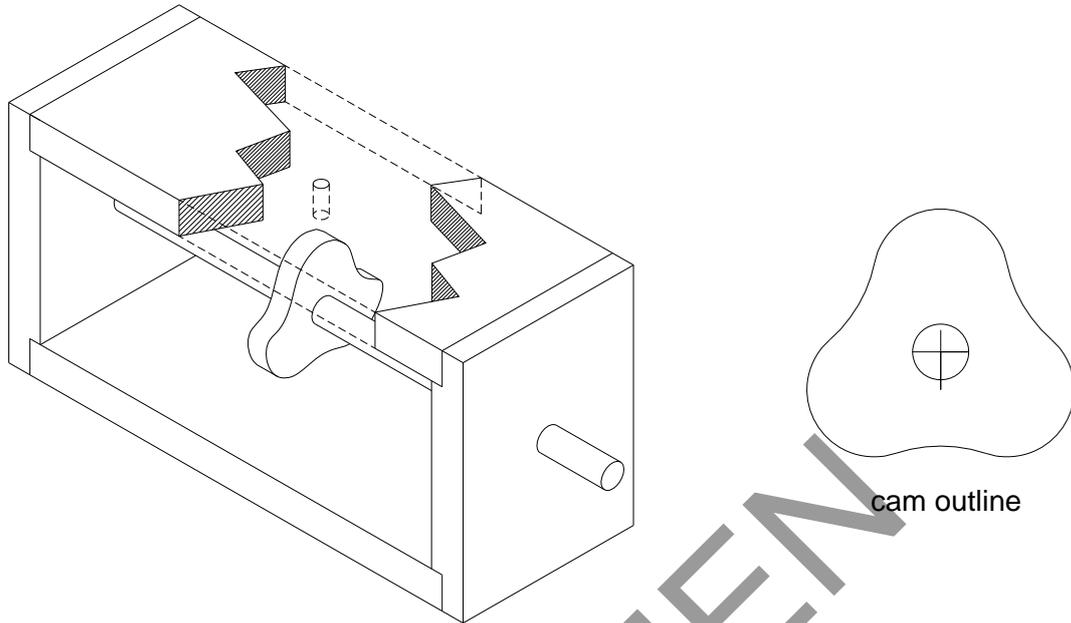
cam outline

Fig. 13

(i) Draw a roller follower on the cam outline in Fig. 13. **[2]**

(ii) Discuss how the shape and position of the follower shown in Fig. 14 influences the movement of the bird as the cam is rotated.

Fig. 14

....

....

....

....

....

....

.... **[4]**

[Turn over

(c) The camshaft is shown in Fig. 15 in position between the sides of the framework.

view in the direction of arrow X
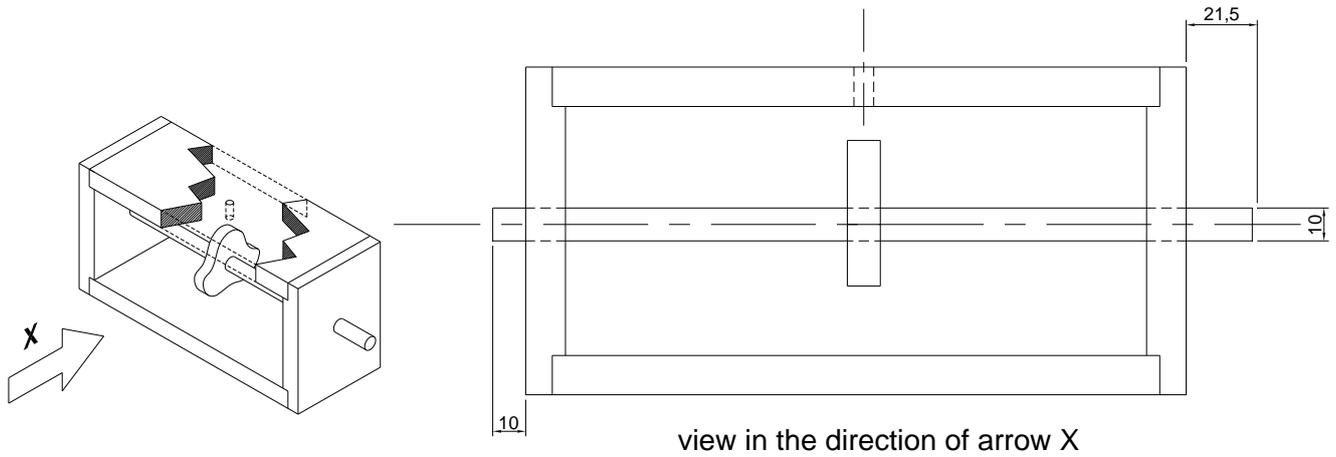
Fig. 15

Use notes and sketches to show a method of keeping the camshaft in position horizontally, preventing any side movement.

Include details of any additional components used.

[3]

[Total: 12]

Section B Total [24]

Paper Total [60]

SPECIMEN

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

General Certificate of Secondary Education

DESIGN & TECHNOLOGY   A514/03

Electronics and Control Systems: Mechanisms

Unit A514: Technical aspects of designing and making:

Specimen Mark Scheme
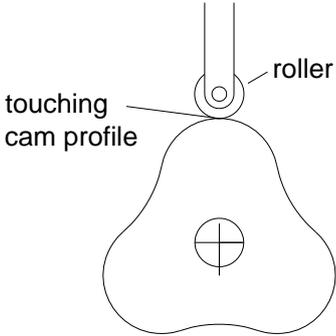
The maximum mark for this paper is **60**.

Section A		
Question Number	**Answer**	**Max Mark**
1(a)(i)	**Bevel** gear. Accept **spur** gear or **pinion**, 1 mark.	**[1]**
(ii)	driven / driver = 15 / 56 = 1 / 3.73 = 1 : 3.73 1 mark for substituting into formula, 1 mark for correct ratio.	**[2]**
(iii)	Speed of drill bit is 50 x 3.73 = 186.6 RPM. 1 mark for correct multiplication. 1 mark for 1st stage, 50 x answer from (ii); error carried forward.	**[2]**
(b)(i)	The brace uses a **second class** lever, accept **second order** lever.	**[1]**
(ii)	Increase in the crank throw will increase torque. Accept using a smaller diameter drill bit in the brace.	**[1]**
(c)*	Level 1 (0-2 marks) Shows limited understanding of the capabilities of the different cramps. There will be little or no use of specialist terms. Answers may be ambiguous or disorganised. Errors of grammar, punctuation and spelling may be intrusive. Level 2 (3-4 marks) Shows some understanding of the capabilities of the different cramps with some analysis of the effectiveness of Cramps A and B. Basic conclusion may be drawn. There will be some use of specialist terms, although these may not always be used appropriately. The information will be presented for the most part in a structured format. There may be occasional errors in spelling, grammar and punctuation Level 3 (5 marks) Shows detailed understanding of the capabilities of the different cramps with analysis of the effectiveness of Cramps A and B. Appropriate conclusions are drawn. Specialist terms will be used appropriately and correctly. The information will be presented in a structured format. The candidate can demonstrate the accurate use of spelling, punctuation and grammar. Evaluation may include reference to: Pitch Threads per inch distance moved for each rotation of handle Effectiveness of cramp handle Handle of cramp A moves effort further from fulcrum	**[5]**
	Total	**[12]**

Section A		
Question Number	**Answer**	**Max Mark**
2(a)(i)	Drive system A is a round belt; Drive system B is a toothed belt; Drive system C is a vee belt; Drive system D is a chain.	**[1]** **[1]** **[1]** **[1]**
(ii)	Benefit of system B could include: • less chance of slipping; • greater surface area in contact with pulley; • less chance of slipping from pulley. 1 mark for clear description of benefit.	**[1]**
(b)(i)	The machine shaft will be rotating **faster** than the motor shaft.	**[1]**
(ii)	Method that prevents rotational movement of pulley on shaft, 1 mark Method that prevents axial movement of pulley on shaft, 1 mark Removable method used, 1 mark.	**[3]**
(c)(i)	Reasons given could include: • Reduced friction; • Reduced surface area in contact; • Less maintenance / reduced frequency of lubrication; • Sealed from dust entry / lubrication leaking. 1 mark each for two suitable reasons or for clear explanation of one reason.	**[2]**
(ii)	The groove inside the plain bearing is for lubrication. Allow reference to oil or grease.	**[1]**
	Total	**[12]**
3(a)(i)	**21 gears** can be selected on the cycle.	**[1]**
(ii)	gear ratio = **49 / 16**, 1 mark = **3.06:1**, 1 mark. distance travelled = 3.06 x 2075 = **6354mm ± 10mm**, 1 mark. Allow error carried forward on distance travelled calculation.	**[3]**
(iii)	Functions of the derailleur mechanism are: • to tension the chain; • to move chain sideways onto different sprocket. 1 mark each, allow mark for understanding shown.	**[2]**

Section A		
Question Number	**Answer**	**Max Mark**
(b)	Properties of the wire are: strength in tension; resistance to bending; resistance to corrosion. 1 mark for each correct property identified.	**[2]**
(c)		
	Correct identification of fulcrum, 1 mark.	**[1]**
	Correct identification of lever position, 1 mark.	**[1]**
(d)	Evaluation could include the following points: • nearer to centre of wheel and will remain drier; • nearer to centre of wheel and are less affected by mud; • hydraulic system more positive action than cable – no stretching. • perforations allow rain and mud to be quickly removed from the braking surface; Explanation including two points 2 x 1 marks Award 2 marks for clear explanation of a single point.	**[2]**
	Total	**[12]**
4(a)	Securing method may include the following features: • Bolt / machine screw / set screw with nut to secure; • Spring washer, star washer or nyloc type nut to prevent fixing coming loose; • spit pin, wired nut or similar or note showing use of locking adhesive (loctite); • Use of rubber mounting pads to cut vibration. 2 x 1 marks for suitable components, 1 mark for workable method clearly shown.	**[3]**
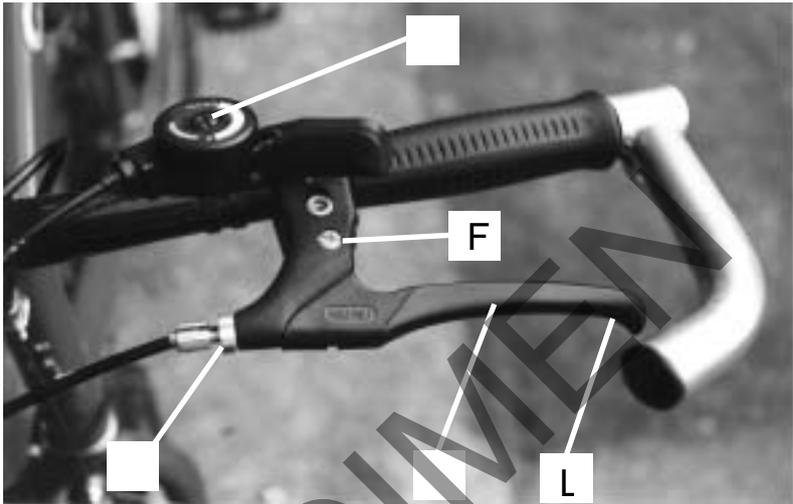
Section B		
Question Number	**Answer**	**Max Mark**
(b)(i)	**Crankshaft** or **cam**. 1 mark.	**[1]**
(ii)	Sketches and notes should include:	
	• drawing or description of a crankshaft;	**[1]**
	• indication of a workable connecting method from crankpin to pressure pad;	**[1]**
	• dimensions to indicate a throw of 25mm, horizontal distance of 50mm;	**[1]**
	• details of both ends of connecting rod shown;	**[1]**
	• clear drawings / descriptions.	**[1]**
(iii)	Attachment method of mechanism to motor: boss on crank to allow grub screw or similar method, 1 mark Clear illustration of practical method, 1 mark.	**[2]**
(c)	Material for pegs should be a suitable bearing material such as nylon, allow acrylic. No mark for wood or manufactured board.	**[1]**
	Total	**[12]**
5(a)	smooth rise and fall, 1 mark.	**[1]**
	smooth rise and rapid fall, 1 mark.	**[1]**
	two irregular rise and falls, 1 mark.	**[1]**

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Section B		
Question Number	**Answer**	**Max Mark**
(b)(i)	Follower touching cam profile, 1 mark Roller clear to see or annotation clear, 1 mark. 	**[2]**
(ii)	Basic discussion, showing limited understanding of how the follower can influence movement. (0-2 marks) Adequate discussion, showing some understanding of how the follower can influence movement with reference to Fig.14 (3 marks) Thorough discussion, showing detailed understanding of how the follower can influence movement with detailed reference to Fig.14 (4 marks) Discussion may include: The diameter of the cam follower will bridge the lowest point on each cam lobe, The cam follower will not travel the full rise and fall of the cam An offset follower will **rotate** on its axis as well as **rising and falling** with the cam profile.	**[4]**

Section B

Question Number	Answer	Max Mark
(c)	The camshaft will require at least one end to be kept in position by bushes, washer and split pin or similar. Movement prevented in one direction, 1 mark. Movement prevented in both directions, 1 mark. Clear details of additional components, 1 mark. E.g. pin — bushes disc to rotate camshaft provides one fixing SPECIMEN	**[3]** **Total** **[12]**
	Section B Total	**24**
	Paper Total	**60**

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)	5			**5**
1(b)	2			**2**
1(c)*			5	**5**
2(a)	5			**5**
2(b)	4			**4**
2(c)	3			**3**
3(a)	6			**6**
3(b)	2			**2**
3(c)	2			**2**
3(d)	2			**2**
4(a)	3			**3**
4(b)	8			**8**
4(c)	1			**1**
5(a)	3			**3**
5(b)	2		4	**6**
5(c)	3			**3**
Totals	**51**	**0**	**9**	**60**

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