2011 Technological Studies

Standard Grade Credit

Finalised Marking Instructions

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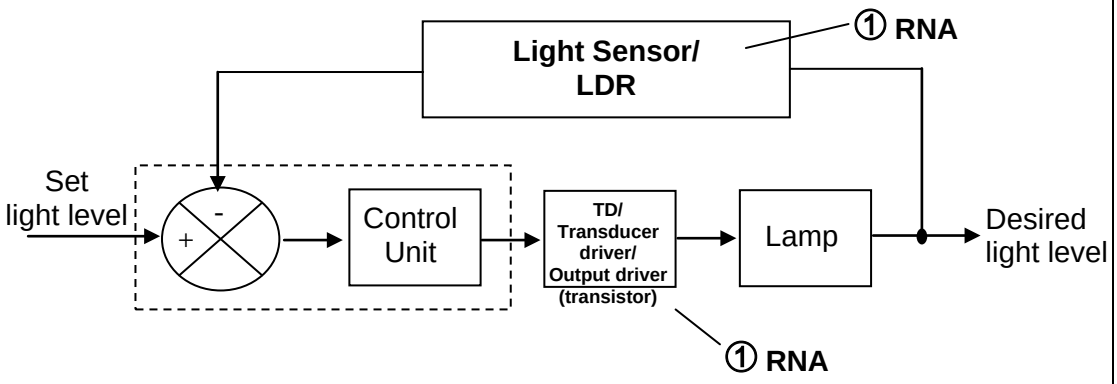
Mark Allocation

Marks	
KU	**RNA**

1. A street lighting system is controlled automatically. When the outside light drops below a set level a lamp comes on.

(a) Complete the diagram below.



2
1
0

(b) State the name of this type of diagram.

Control diagram ① KU

1
0

(c) Describe the function of an error detector.

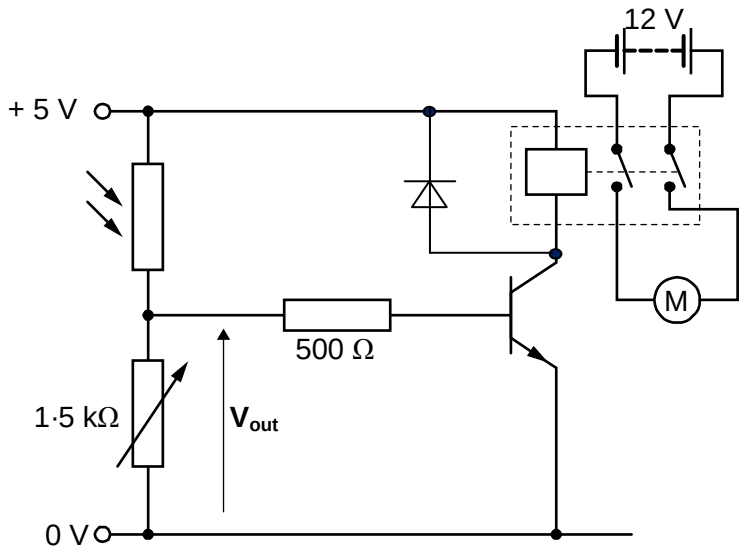
Compares the set level to the feedback level

① KU ① KU

2
1
0

	Marks	
	KU	RNA

2. A prototype electronic circuit is shown below.



(a) State the full name of an LDR.

Light Dependent Resistor — ① **KU**

KU	RNA
1 0	

The variable resistor and the LDR form a voltage divider sub-system.

(b) Describe the operation of the **voltage divider sub-system**.

As the light level increases the LDR's resistance decreases.
As the light level increases V_{out} increases.
The variable resistor acts as a sensitivity control etc

RNA
3 2 1 0

① **RNA for each correct descriptive statement up to 3.**

(c) (i) Determine, with reference to the Data Booklet, the resistance of the LDR at 300 lux.

400 (-420)

RNA
1 0

(ii) Calculate V_{out} from the voltage divider sub-system at 300 lux.

$$V_{out} = \frac{R_1}{R_2} \times V_{CC}$$

$$= \frac{1500}{1900} \times 5$$ ① **RNA for substitution**

FTE →

= **3·95 V** ① **RNA for answer from given working**

RNA
2 1 0

	Marks	
	KU	RNA

2. (continued)

(d) Complete the circuit diagram to show how a diode could be used to protect the transistor from back-voltage (e.m.f.).

	1	2
	0	1
		0

① KU for diode symbol
① RNA for wiring
① RNA for orientation of diode

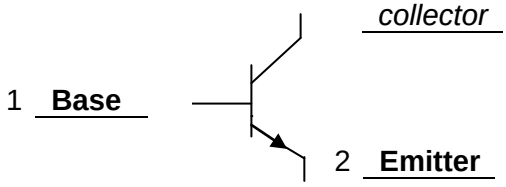
(e) The transistor is fully switched on when V_{BE} is 0·7 V.

(i) State the name given to this condition.

Saturated/saturation **① KU**

1	
0	

(ii) The symbol for a transistor is shown below. Label the connections **1** and **2**.



① KU for each correct
(① KU if names reversed)

2	
1	
0	

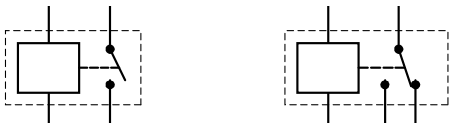
(f) (i) Explain why a relay is often used with electronic circuits.

It allows a low powered circuit to control a high powered circuit. There is no physical link between the circuits. Control circuits can't work with very high currents

① KU for each correct answer up to 2

2	
1	
0	

(ii) A DPST (double pole single throw) relay is used in the circuit. State the names of the types of relays shown below.



SPST/ Single Pole Single Throw **① KU**

SPDT/ Single Pole Double Throw **① KU**

2	
1	
0	

(iii) State the name of a relay that would allow forward **and** backward control of a motor.

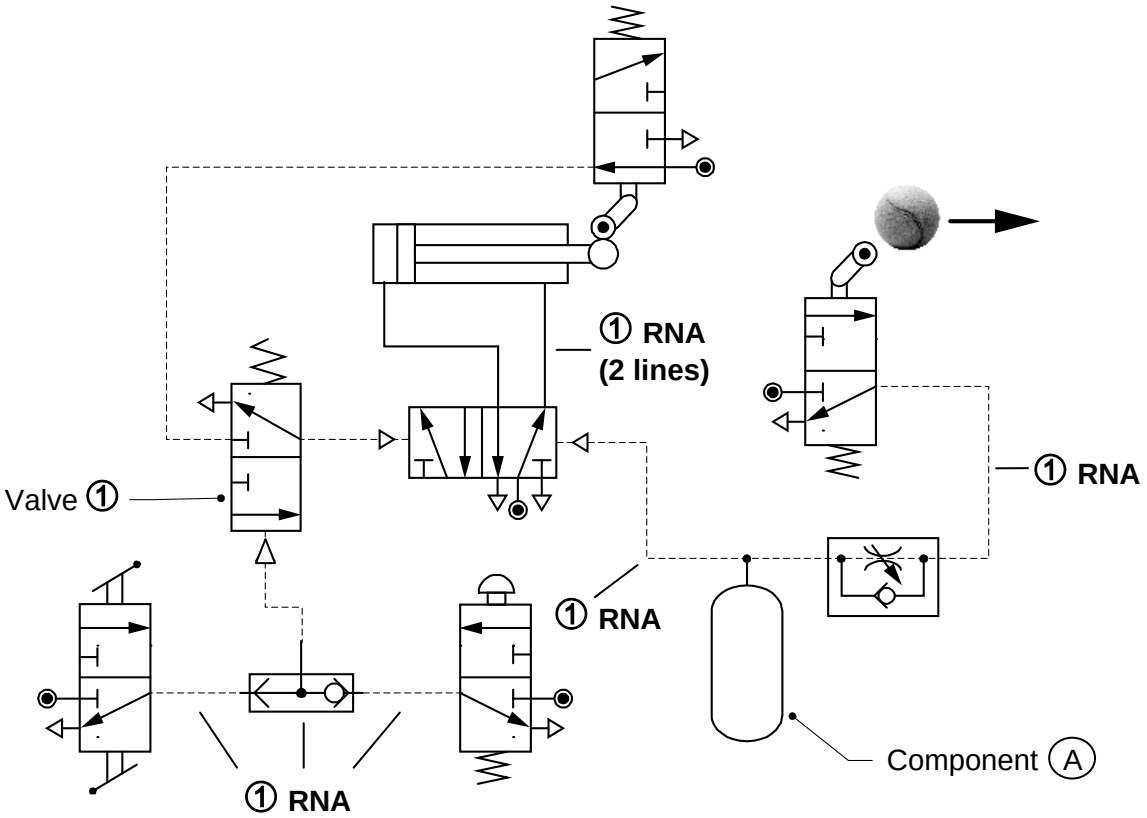
DPDT/Double Pole Double Throw **① KU**

1	
0	

	Marks	
	KU	RNA

3. A pneumatic circuit is used to serve tennis balls during practice sessions.

The system will serve automatically when a lever is actuated or manually each time a button is pressed. There is a delay between each ball being served.



① KU for at least 1 correct pilot line

(a) Complete the piping of the pneumatic circuit. | **1** | **4 3 2 1 0**

(b) State the full name of the following components.

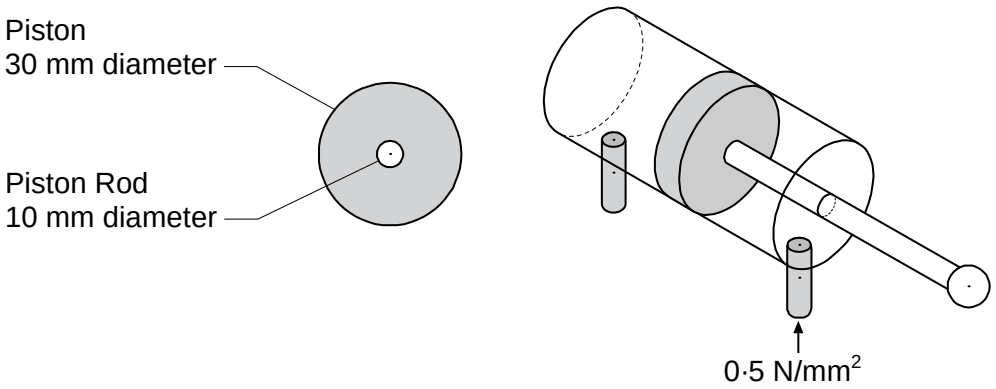
(i) Component (A) **Reservoir** **① KU** | **1 0**

(ii) Valve (1) **3/2/Pilot/Spring Return** | **3 2 1 0**

	Marks	
	KU	RNA

3. (continued)

The piston below **instrokes** when air is supplied at a pressure of 0·5 N/mm^2 to the cylinder.



(c) Calculate the instroking force.

A_1 = πr^2 = $\pi \times 15^2$ = 706mm^2 — ① **RNA for correct area calculation**

A_2 = πr^2 = $\pi \times 5^2$ = 78mm^2 — ① **RNA for combined area**

A_{TOTAL} = $A_1 - A_2$ = 628mm^2

F = 628 × 0·5 = 314N — ① **RNA for subs**

(if only using A_1 max 2 marks) — ① **RNA for ans from working**

	RNA
	4
	3
	2
	1
	0

(d) Describe **two** ways of reducing the **outstroking** force applied by a piston.

1 **Reduce area of cylinder** — ① **KU**

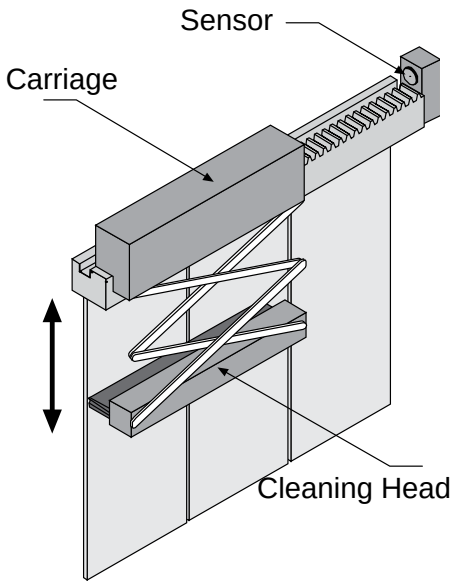
Larger piston rod diameter

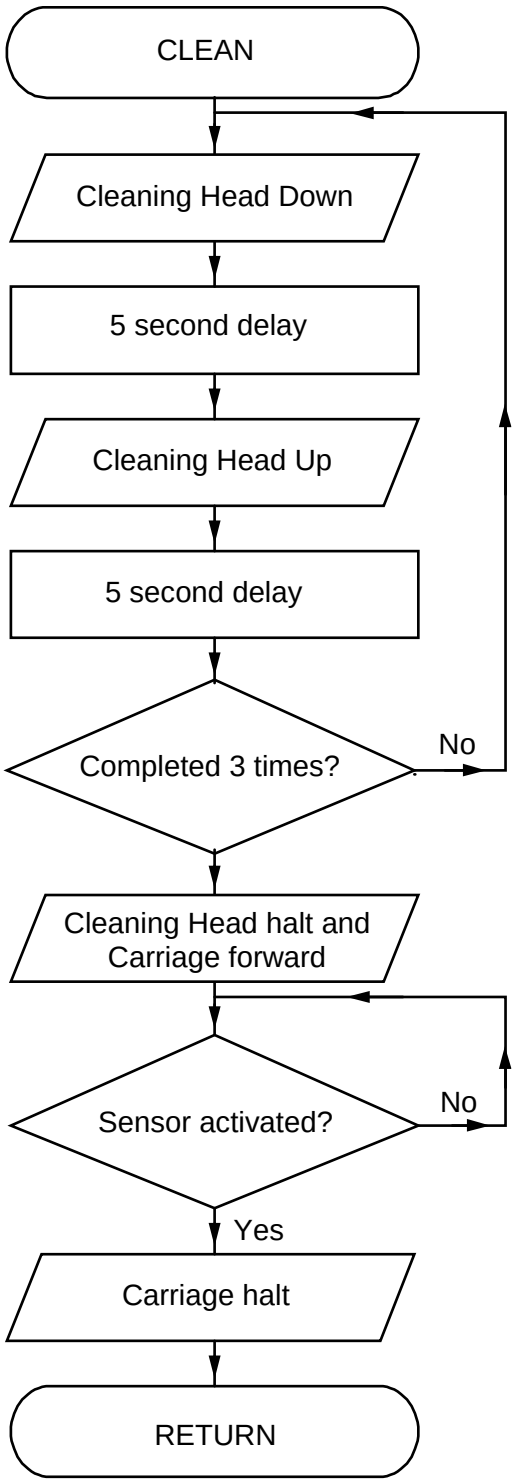
2 **Reduce main air pressure** — ① **KU**

	KU
	2
	1
	0

4. A microcontroller is used to operate an automatic window cleaning system.

The flowchart for a sub-procedure used to control the system is shown below.





Marks	
KU	RNA

4. (continued)

Input and output connections to the microcontroller are shown in the table below.

Input Connection	Pin	Output Connection
	7	Cleaning Head Up
	6	Cleaning Head Down
	5	Carriage forward
	4	
	3	
	2	
	1	
Sensor	0	

Complete, with reference to the Data Booklet, flowchart and the input/output table, the PBASIC control program for sub-procedure 'CLEAN'.

	init: symbol counter = b0		
	clean: **for counter = 1 to 3**	*'set for ... next loop to 3*	① **RNA**
OR **low 7** / **high 6**	**let pins = %0100000**	*'cleaning head down*	① **RNA**
	pause 5000		
OR **low 6** / **high 7**	**let pins = %10000000**	① **RNA**	① **RNA for both**
	pause 5000		
alternative position for low 7			
	next counter		① **RNA**
OR **high 5** / **low 7**	**let pins = %00100000**		① **RNA**
	label: if pin0 = 0 then label		① **RNA**
OR **let pins = 0**	**let pins = %00000000 or low 5**		① **RNA**
	return		① **RNA**

If candidates do not switch off pin then max – 2 marks

KU	RNA
	9 8 7 6 5 4 3 2 1 0

	Marks	
	KU	RNA

5. A car manufacturer has produced an electric sports car.

The car's batteries are charged for 20 minutes from a 120 V supply providing 7 A.

(a) Calculate the electrical energy supplied.

① RNA time in seconds calculation

E_e = I t V
= 7 × (20 × 60) × 120 **① RNA for substitution**
= 1008000 J **① RNA for answer from given working**
= 1 MJ

3 2 1 0

The batteries provide 23 kW but the electric motor only produces 17·8 kW of useful output power.

(b) (i) Calculate the efficiency of the electric motor.

$$\eta = \frac{\text{useful power out}}{\text{total power in}}$$

① RNA for substitution

$$= \frac{17 \cdot 8}{23} = 0 \cdot 774\ (77 \cdot 4\%)$$

① RNA for answer from given working

2 1 0

(ii) Explain why the electric motor is not 100% efficient.

Energy is lost/due to friction etc or sound/heat

① RNA **① RNA**

2 1 0

	Marks	
	KU	RNA

5. (continued)

(c) Explain why it is important to make systems as efficient as possible.

Reduces energy consumption

Reduces cost of running system etc ① **KU** — **1 0**

Electrical energy can be generated from a variety of different sources.

(d) (i) State **two** examples of **finite** energy sources.

1 **Coal/gas/oil** ① **KU each up to 2** — **2 1 0**

2

(ii) Explain the **advantages** (other than cost) of using **renewable** energy source.

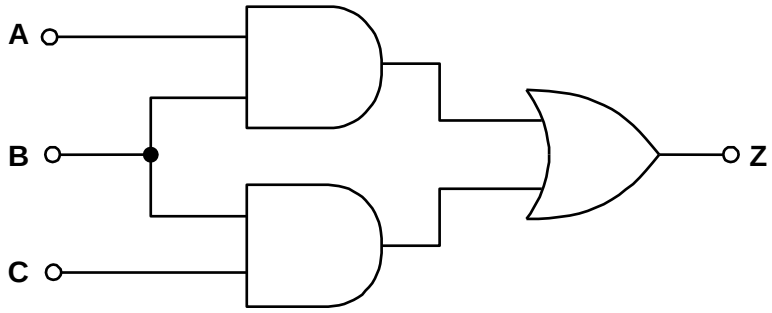
Energy source can be replenished/won't run out

Reduces pollution/greenhouse gas etc — **2 1 0**

Uses less resources ① **KU each up to 2**

Marks	
KU	RNA

6. The following logic diagram is required for an electronic alarm system.



(a) Develop the Boolean expression for **Z**, in terms of **A**, **B** and **C**. **2 1 0**

Z = (A•B) + (B•C)

① RNA for ANDing inputs

① RNA for OR conditions

Alt $(\overline{A}$•B•C) + (A•$\overline{B}$•C) + (A•B•C)

(b) Complete the truth table below for the logic diagram.

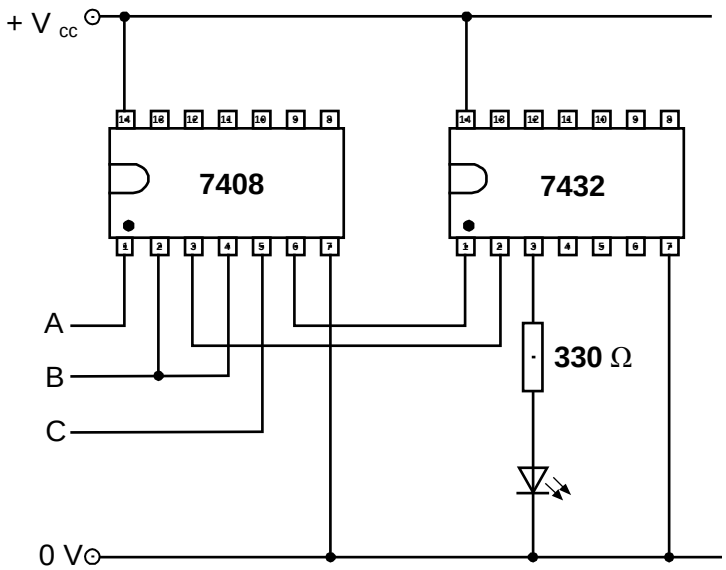
A	B	C	Z	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	**1**	①
1	0	0	0	**3**
1	0	1	**0**	① **2**
1	1	0	**1**	① **1**
1	1	1	1	**0**

① RNA each correct entry

Marks	
KU	RNA

6. (continued)

A wiring diagram for the circuit is shown below.



(c) State why a resistor is placed in series with an LED.

Protects the LED (from large current) **① KU**

1
0

(d) The following table compares characteristics of TTL and CMOS.

Complete the table to match the characteristics to the correct Integrated Circuit (IC) family.

Characteristic	TTL	CMOS
Large fan out		✓
Higher power consumption	✓	
Easily damaged by static electricity		✓
Faster switching speed	✓	
Can use supply voltages from 3-18 V		✓

① KU for each correct single entry

4
3
2
1
0

Marks	
KU	RNA

7. Manufacturing companies often use microcontrollers instead of hardwired electronic circuits.

(a) State the full name of EEPROM as used in a microcontroller.

Electrically Erasable Programmable Read Only Memory

1
0

(b) Complete the following table to describe the function and a characteristic of the named microcontroller sub-systems.

Name	Function	Characteristic
ROM	*Stores PBASIC language for microcontroller operations.*	*Data remains after power is switched off.*
RAM	Stores data required when running the program.	Data will not remain when power is removed.
EEPROM	Stores the program.	Data remains after power is switched off. Data can be re-written.

① KU for each correct entry

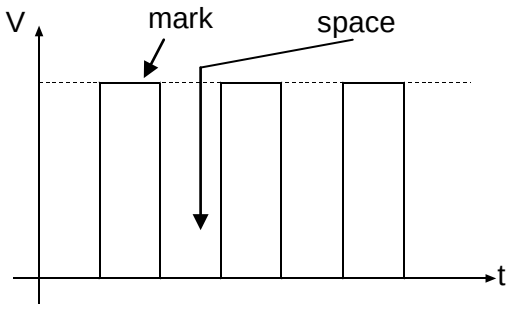
4
3
2
1
0

Marks	
KU	RNA

7. (continued)

A microcontroller is used to vary the speed of a fan in an air-conditioning system.

(c) (i) Describe, using appropriate terminology, how Pulse Width Modulation (PWM) could be used to control the speed of a d.c. motor. You may use a sketch to illustrate your answer.



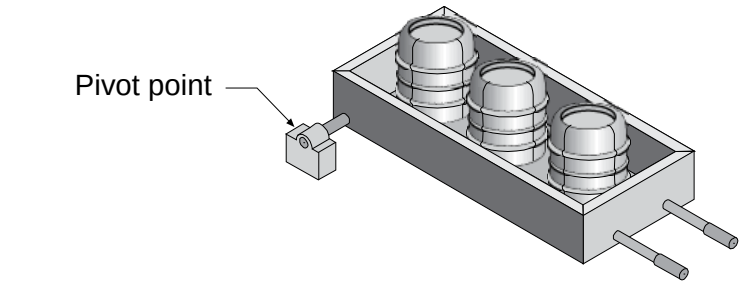
	KU	RNA
① KU for pulsed/on-off signal		
① KU for identifying/describing mark and space	**3**	
① KU for identifying/describing that speed is determined by mark/space ratio	**2**	
	1	
	0	

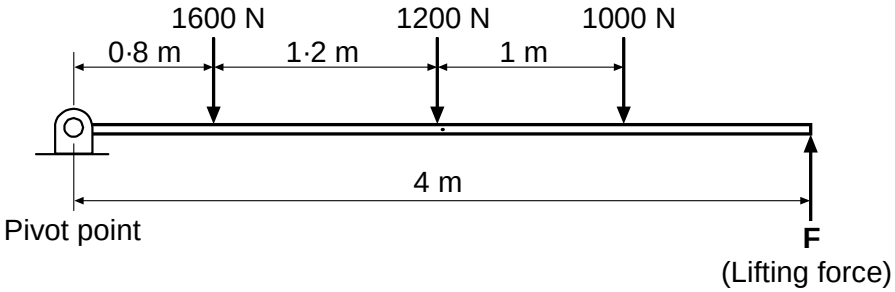
(ii) Describe the advantage of using PWM to control a motor's speed.

	KU	RNA
Maintains a high torque/smooth turning		
	1	
Only required 1 output pin from microcontroller	**0**	

	Marks	
	KU	RNA

8. A contestant in a weight-lifting competition is required to complete a "barrel lift". A simplified diagram is shown below.





(a) Calculate the size of the lifting force of **F**. (Take moments about the pivot point).

∑CWM = ∑ACWM

(1600 × 0·8) + (1200 × 2) + (1000 × 3) = F × 4 — ① **RNA for substitution**

$$\mathbf{F = \frac{6680}{4}}$$ — ① **RNA for transposition**

= 1670 N — ① **RNA for answer from given working**

KU	RNA
	3
	2
	1
	0

(b) Describe **two** ways of reducing friction at a pivot point.

1 **Lubrication/ball bearing/using alternative materials**

2 ① **KU each up to 2**

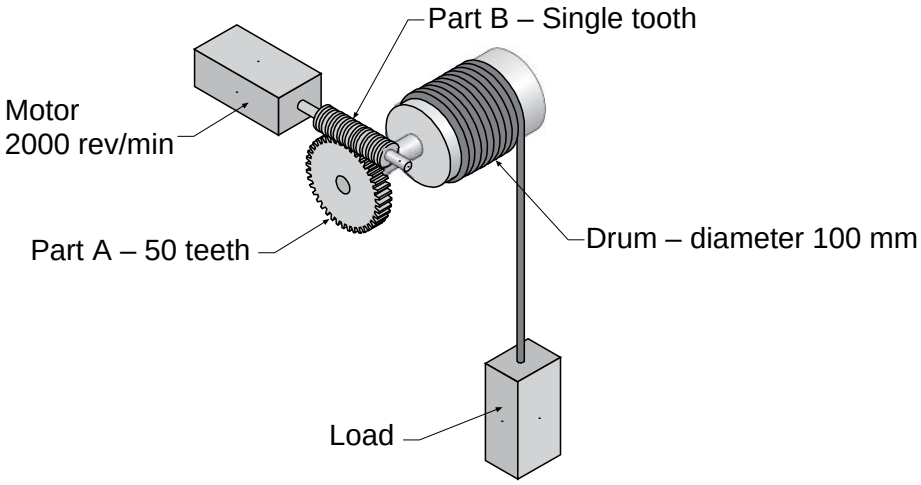
KU	RNA
2	
1	
0	

	Marks	
	KU	RNA

8. (continued)

In order to set up some equipment a winching system is used.

(c) (i) Calculate the **linear** speed of the load as it is raised. (Ignore the thickness of the rope.)



Speed of Drum $2000 \times 1 = 50 \times X$

$$X = \frac{2000}{50}$$

$= 40$ rev/min

$\text{cir} = \pi d$

$= 3{\cdot}14 \times 0{\cdot}1$ m

$= 0{\cdot}314$ m ① RNA for circumference

① RNA for drum speed

Speed of Load Drum speed × Circumference

$= 40 \times 314$

$= 12560$ mm/min

OR

$= 0{\cdot}2$ m/s

① RNA for answer from working

	3
	2
	1
	0

(ii) State the name of the two parts of the mechanism that links the motor and the drum.

Part A **Wheel** ① KU

Part B **Worm** ① KU

① KU total if answers reversed

2	
1	
0	

(d) State the name of a mechanism that could be used to convert:

(i) rotational to linear motion;

Rack & Pinion ① KU

1	
0	

(ii) reciprocating into rotational motion.

Crank & Slider ① KU

1	
0	

[END OF MARKING INSTRUCTIONS]