FOR OFFICIAL USE

C

	KU	RNA
Total Marks		

4040/402

NATIONAL QUALIFICATIONS 2011

THURSDAY, 12 MAY
2.35 PM – 4.05 PM

TECHNOLOGICAL STUDIES
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day	Month	Year

Scottish candidate number

Number of seat

1 Answer all the questions.

2 Read every question carefully before you answer.

3 Write your answers in the spaces provided.

4 Do **not** write in the margins.

5 Do **not** sketch in ink.

6 All dimensions are given in millimetres.

7 **Show all working and units where appropriate.**

8 Reference should be made to the Standard Grade and Intermediate 2 Data Booklet (2008 edition) which is provided.

9 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.

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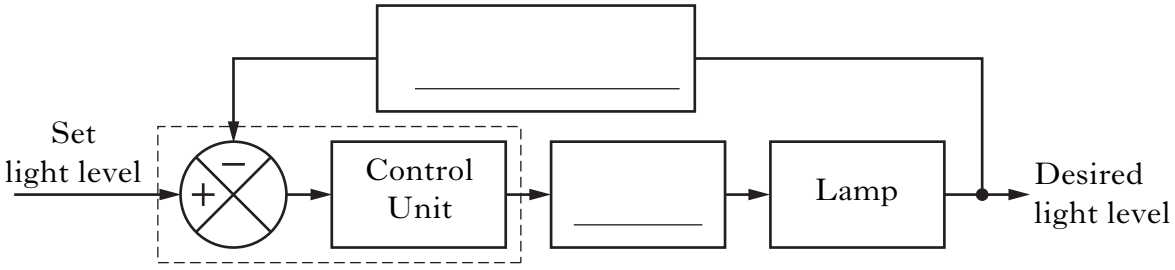
1. A street lighting system is controlled automatically. When the outside light drops below a set level a lamp comes on.

(*a*) Complete the diagram below.



2 1 0

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

_____

1 0

(*c*) Describe the function of an error detector.

_____

_____

_____

2 1 0

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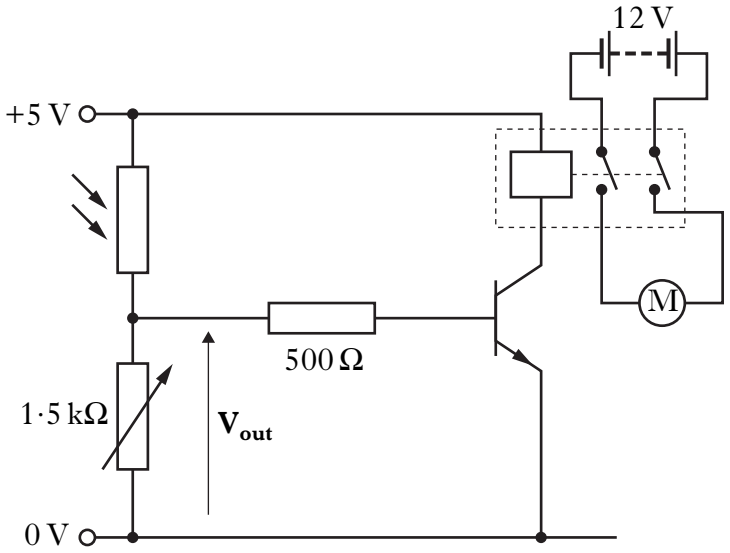
2. A prototype electronic circuit is shown below.



(*a*) State the full name of an LDR.

_____ **1 0**

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

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

_____

_____

_____ **3 2 1 0**

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

_____ **1 0**

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

2 1 0

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2. (continued)

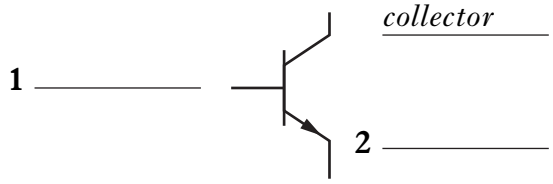
(*d*) Complete the circuit diagram to show how a diode could be used to protect the transistor from back-voltage (e.m.f.). **1 0** **2 1 0**

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

(i) State the name given to this condition.

_____ **1 0**

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



2 1 0

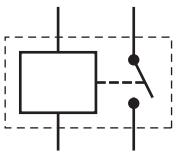
(*f*) (i) Explain why a relay is often used with electronic circuits.

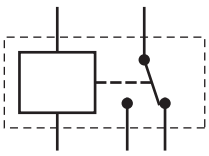
_____

_____ **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.





_____ _____ **2 1 0**

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

_____ **1 0**

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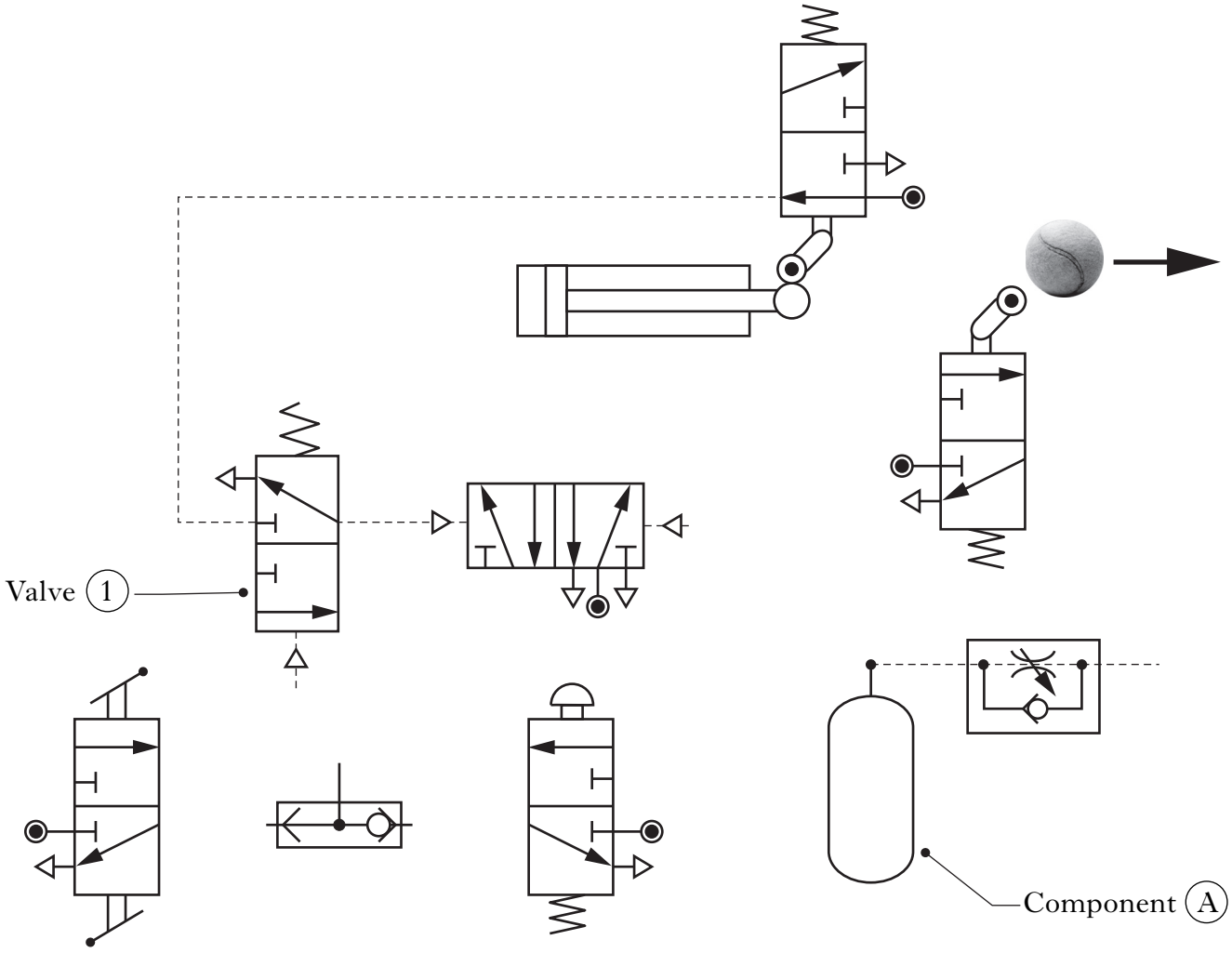
3. A pneumatic circuit is used to serve tennis balls during practice sessions.

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.



		KU	RNA
			4
			3
			2
		1	**1**
(*a*)	Complete the piping of the pneumatic circuit.	**0**	**0**
(*b*)	State the full name of the following components.		
		1	
(i)	Component (A) _____	**0**	
		3	
		2	
		1	
(ii)	Valve (1) _____	**0**	

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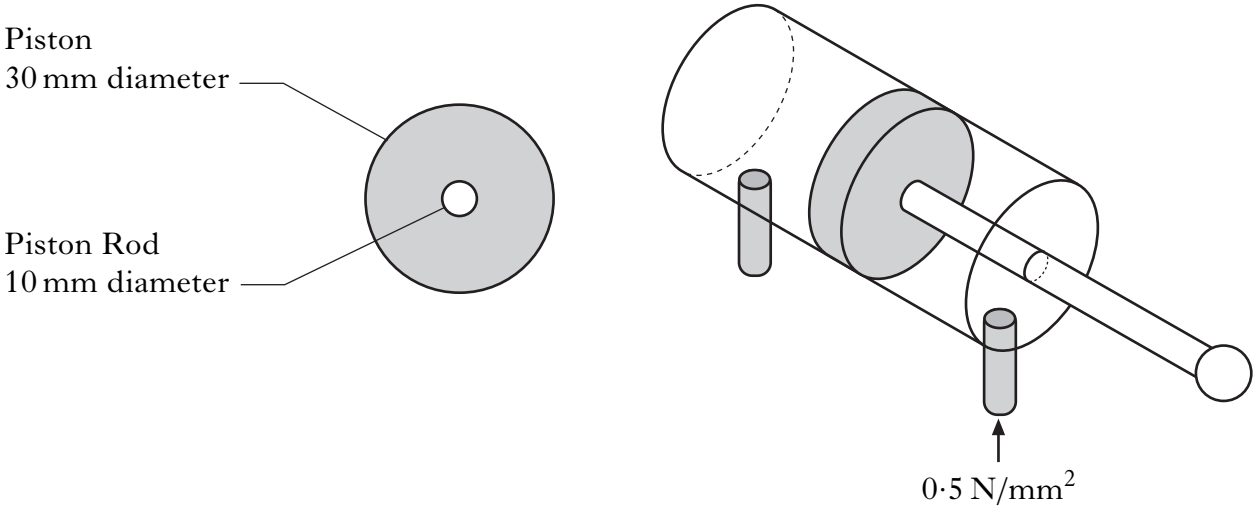
3. (continued)

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.

4
3
2
1
0

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

1 _____

_____

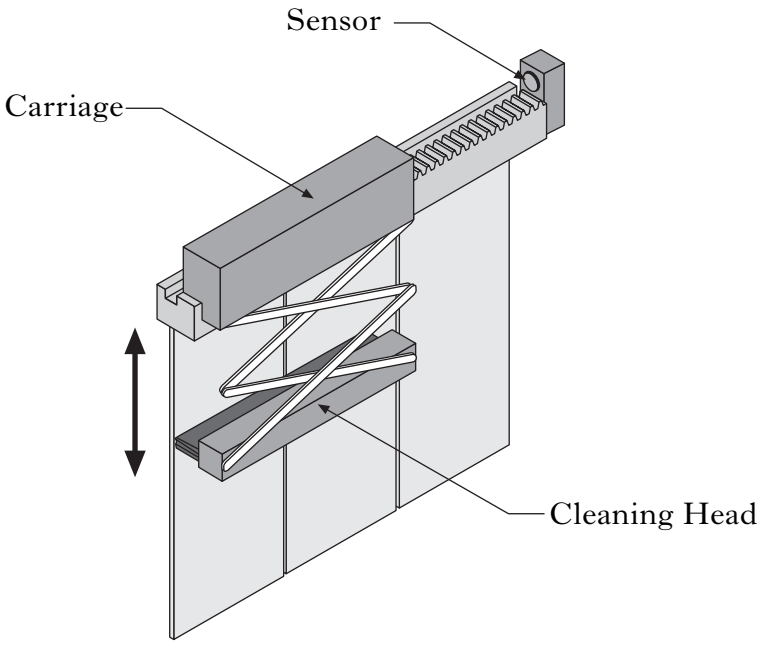
2 _____ **2**

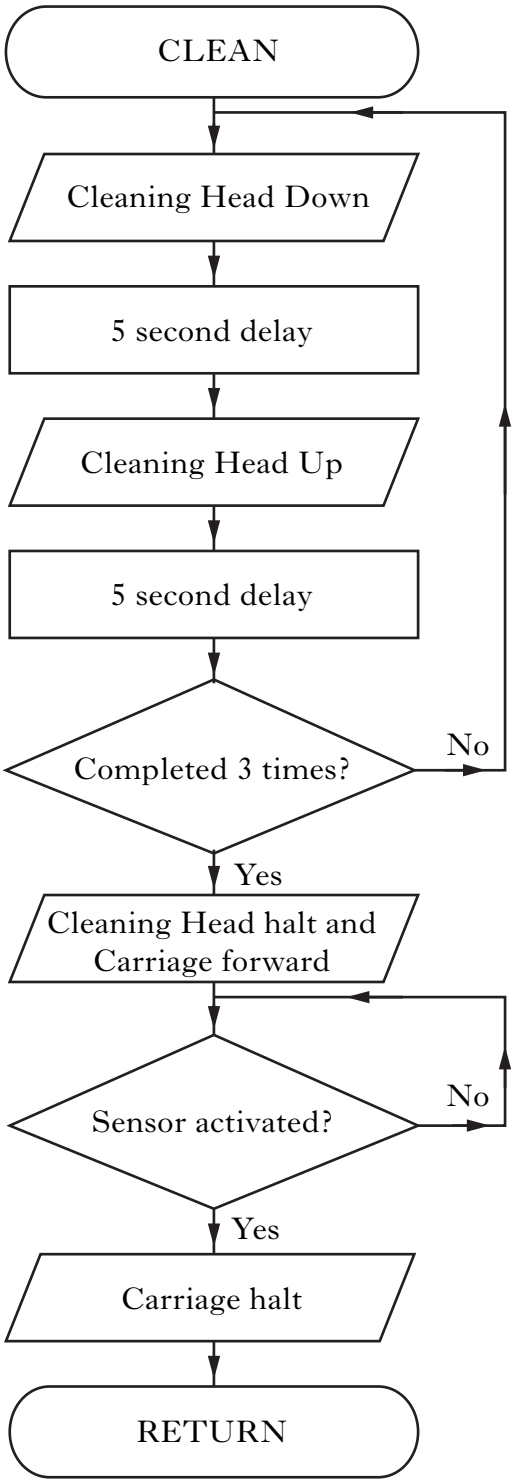
_____ **1**
0

[Turn over

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.





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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:                                  'set for . . . next loop to 3

                                        'cleaning head down
```

9 8 7 6 5 4 3 2 1 0

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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.

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.

2 1 0

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

_____

_____

2 1 0

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5. (continued)

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

_____

_____

_____ **1 0**

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

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

1 _____ **2**

1

2 _____ **0**

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

_____

_____ **2**

1

_____ **0**

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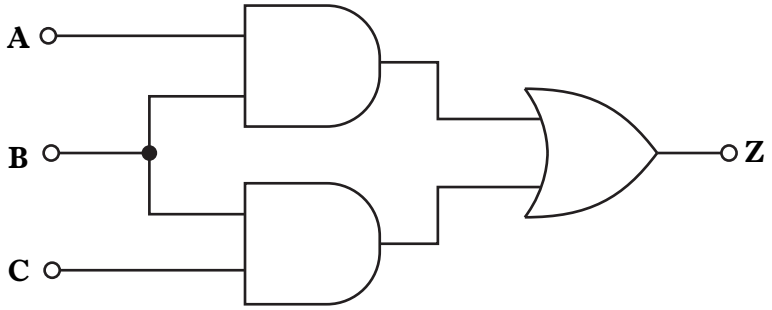
6. The following logic diagram is required for an electronic alarm system.



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

Z = _____

(*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	0	0	0
1	0	1	
1	1	0	
1	1	1	1

3 2 1 0

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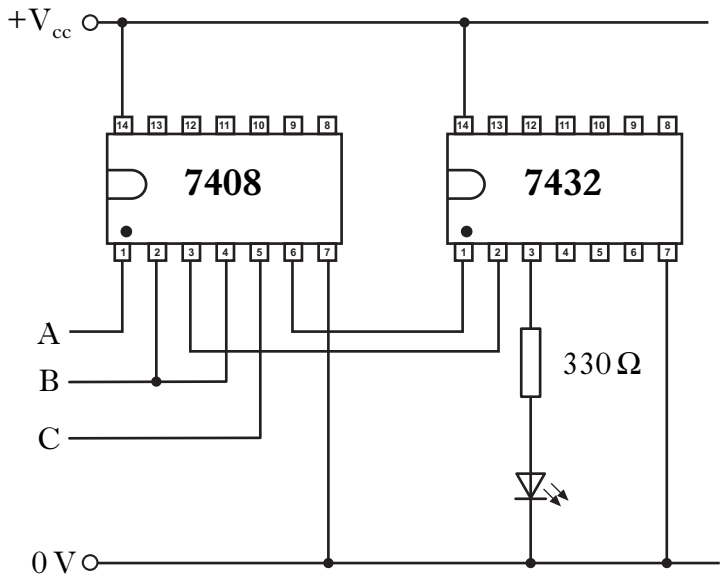
6. (continued)

A wiring diagram for the circuit is shown below.



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

_____

_____

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		

4
3
2
1
0

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

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

_____

_____

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	_____	_____
EEPROM	_____	_____

4 3 2 1 0

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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.

3 2 1 0

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

1 0

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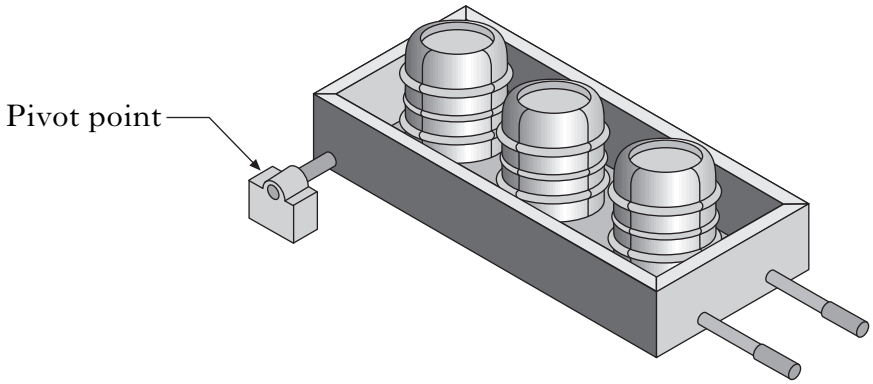
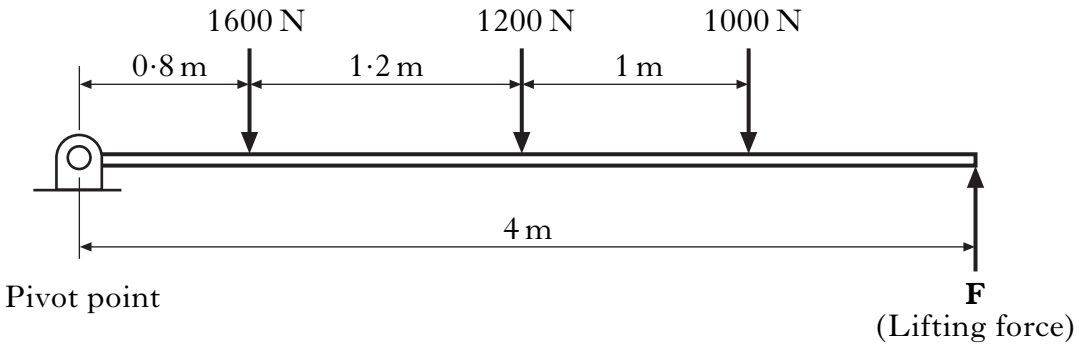
8. A contestant in a weight-lifting competition is required to complete a "barrel lift". A simplified diagram is shown below.





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

3
2
1
0

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

1 _____ **2**

2 _____ **1**
0

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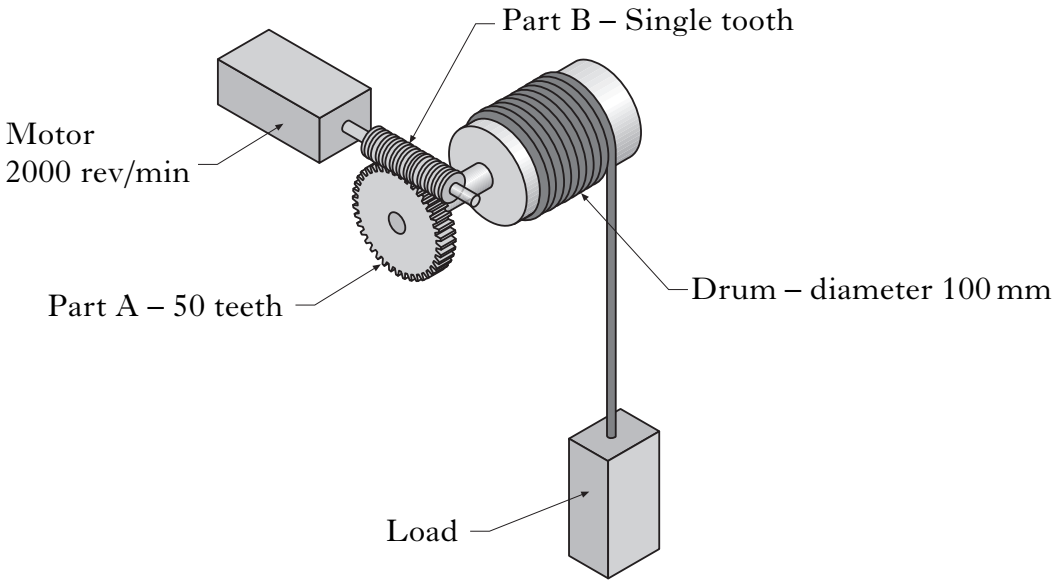
8. (continued)

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.)



3
2
1
0

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

Part A _____ **2**
1

Part B _____ **0**

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

(i) rotational to linear motion;

_____ **1**
0

(ii) reciprocating into rotational motion.

_____ **1**
0

[*END OF QUESTION PAPER*]

ACKNOWLEDGEMENT

Credit Level Question 5—Photograph of a Tesla electronic sports car is reproduced by kind permission of Tesla Motors Ltd.

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