C

KU   RNA

Total Marks

4040/31/01

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.
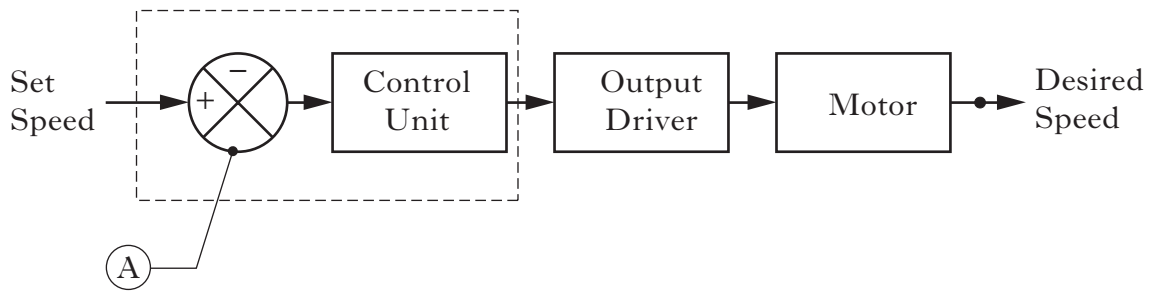
SQA

1. A treadmill uses closed loop control to maintain a constant speed.

(*a*) Describe closed loop control.

_____

_____

_____

An incomplete control diagram for the treadmill is shown below.
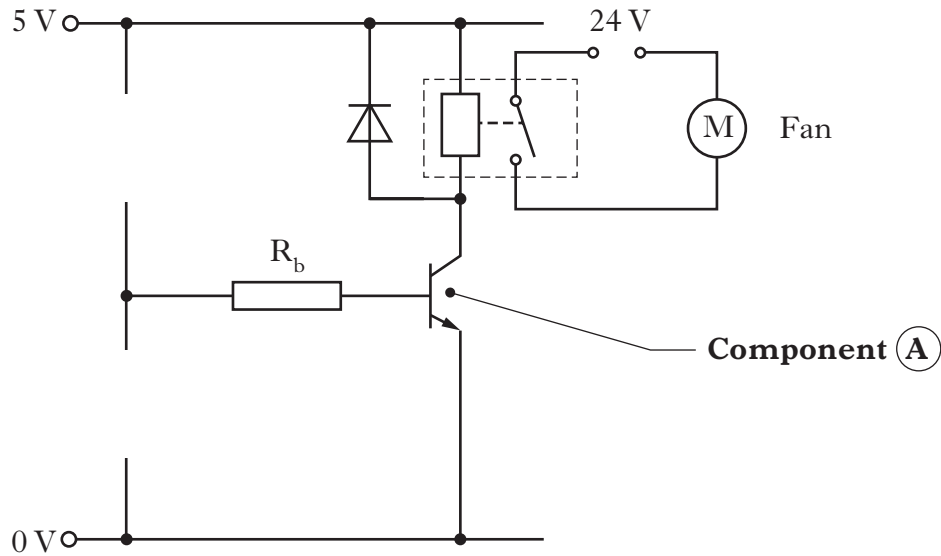
(*b*) (i) State the name of symbol (A).

_____

(ii) Complete the control diagram above.

2. A cooling system turns on a fan when the temperature in a room gets too high.

(*a*)   Complete the circuit to show a temperature sensor, with sensitivity control.

(*b*)   State the name of **Component** (**A**).

_____

Component (**A**) is fully switched on at 0·7 V.

(*c*)   State the name given to this condition.

_____

(*d*)   A diode is normally connected in parallel across devices such as relays.
State the function of the diode.

_____

_____

(*e*)   Explain why an engineer may test a new circuit with simulation software
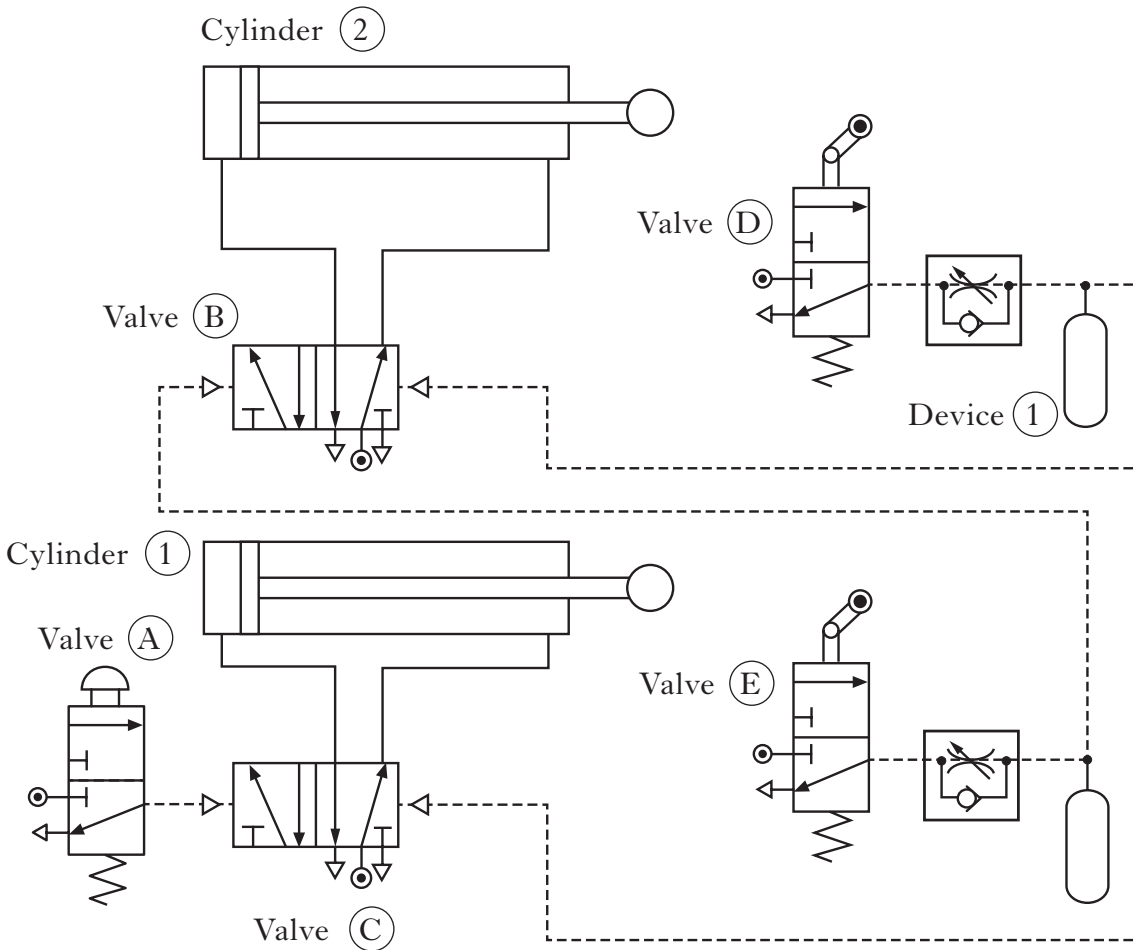before constructing a prototype.

_____

_____

[Turn over

3. A pneumatic system controls the movement of a 'low-rider' car. When activated, two cylinders raise the front and rear of the car.

Cylinder ②

Valve Ⓑ

Valve Ⓓ

Device ①

Cylinder ①

Valve Ⓐ

Valve Ⓔ

Valve Ⓒ

(*a*)   Describe, using appropriate terminology, the operation of the circuit.

3. **(continued)**

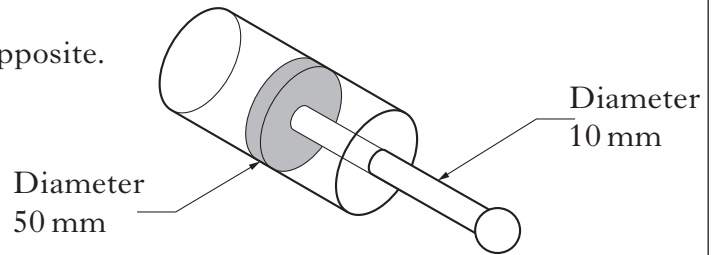(*b*)   State the **full name** of the following components.

   (i)   Valve (C) _____

   (ii)   Device (1) _____

(*c*)   (i)   State the name of the **actuator** that is often used with an air bleed to sense changes in air pressure.

   _____

   (ii)   Draw the symbol for this actuator.

Detail of Cylinder (1) is shown opposite.

Diameter
10 mm

Diameter
50 mm

(*d*)   Calculate the **effective** area of the piston when the piston rod is **instroking**.

(*e*)   Describe the **function** of main air and pilot air.

Main air _____

Pilot air _____

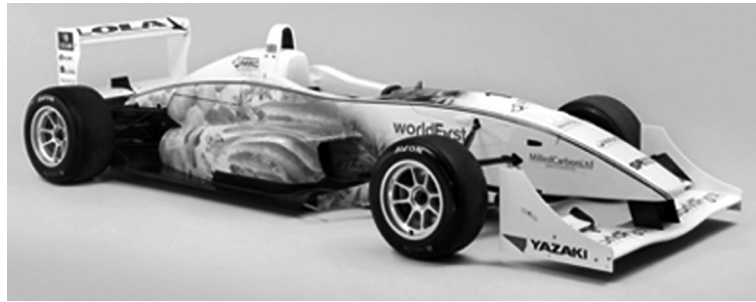**4.** An environmentally friendly racing car has a mass of 600 kg.

(*a*) Calculate, showing all working and units, the velocity of the car when it has 925 kJ of kinetic energy.

When the car uses 150 MJ of fuel it produces 63 MJ of useful energy.

(*b*) Calculate the efficiency of the car.

As the car slows its kinetic energy reduces.

(*c*) Explain what happens to this kinetic energy.

_____

_____

_____

4. **(continued)**

Solar power is increasingly being used as an alternative source of energy in place of fossil fuels.

(*d*) Describe **one** advantage and **one** disadvantage of using solar power.
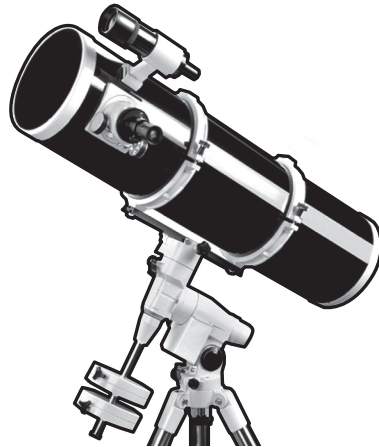
Advantage _____

_____

Disadvantage _____

_____

(*e*) Describe **one** reason why fossil fuels are still being used.

_____

_____

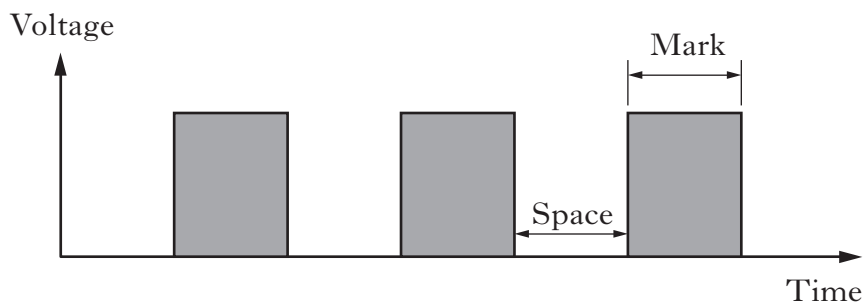(*f*) Describe **two** reasons why systems should be made as efficient as possible.

_____

_____

_____

_____

[Turn over

5. A motorised telescope is operated by a microcontroller.

The microcontroller uses PWM to control the speed of the motor.
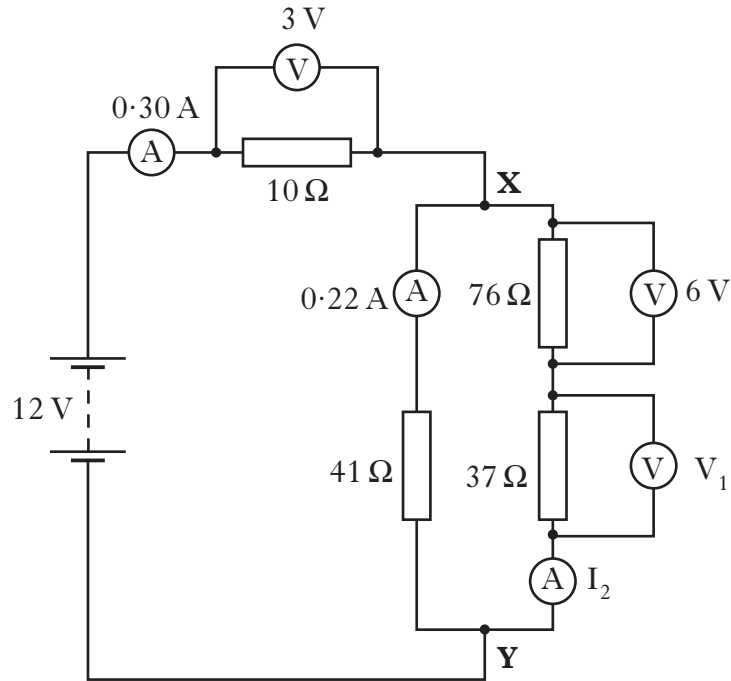

(*a*) State the full name of PWM.

_____

(*b*) Describe, using appropriate terminology, how PWM could be used to vary the speed of a motor.

_____

_____

_____

6. An Electronic Engineer has built the prototype circuit shown below.

(a)   (i)   Calculate the overall resistance between points **X** and **Y**.

(ii) Calculate the total resistance of the circuit.

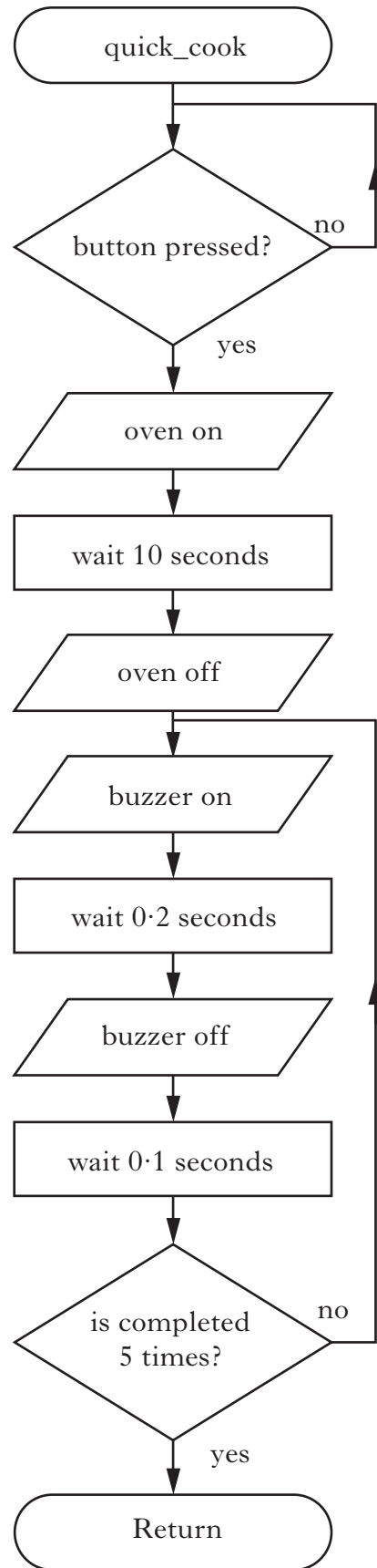(b)   Calculate the current I_2.

(c)   Calculate the voltage V_1.

7. A microwave oven is operated by a microcontroller.

—Button

The program makes use of a sub-procedure 'quick_cook', shown on the flowchart.

quick_cook

button pressed? — no

yes

oven on

wait 10 seconds

oven off

buzzer on

wait 0·2 seconds

buzzer off

wait 0·1 seconds

is completed 5 times? — no

yes

Return

7. **(continued)**

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

| Input Connection	Pin	Output Connection
	7	Buzzer
	6	Oven
	5	
	4	
	3	
	2	
	1	
Button	0	

Complete the PBASIC program for sub-procedure 'quick_cook'. Make reference to the flowchart, Data Booklet, and the input/output connections.

quick_cook:

8. A museum uses an electronic entry system to count the number of visitors. It is activated by a master switch. The logic diagram for part of the system is shown below.

Sensor B

Sensor A

Sensor A

Sensor B

Master Switch C

Z–Output to
counter subsystem
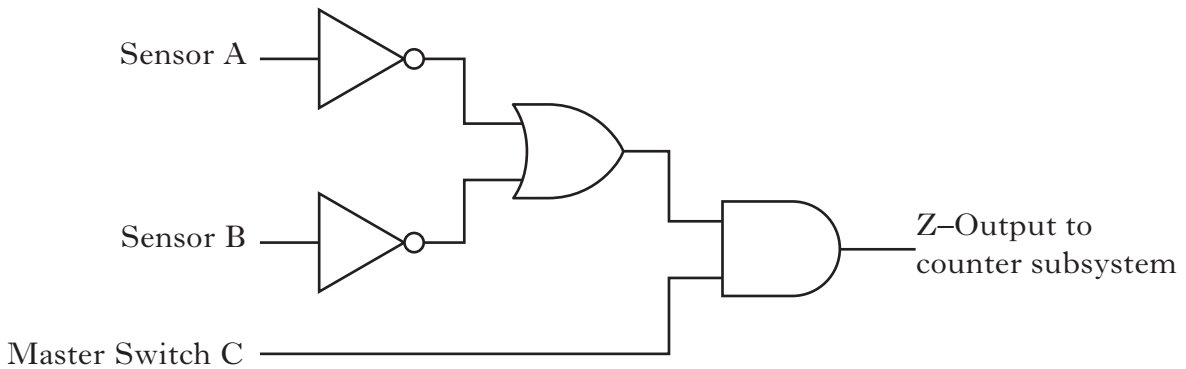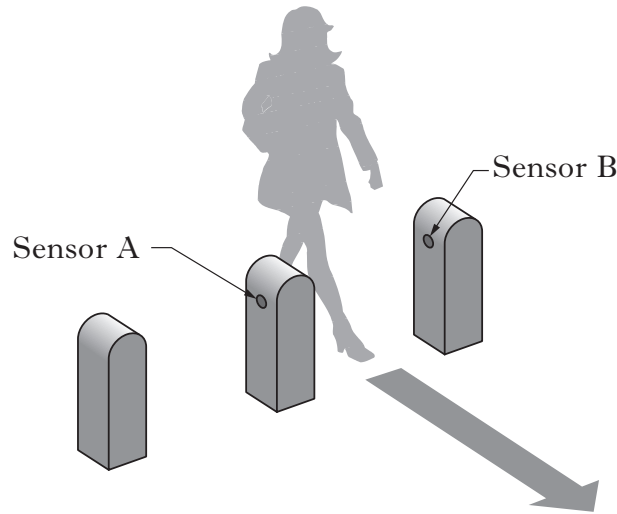
(a) Complete the Boolean expression for Z in terms of A, B and C, with reference to the logic diagram above.

Z = _____

3
2
1
0

(b) State, with reference to the Data Booklet, the Integrated Circuit (IC) **numbers** required to construct the circuit. The first one is given.

IC number: 7408, _____ , _____

1
0

(c) State the **full** name of the 7408 IC.

_____

1
0

8. **(continued)**

(*d*) Complete the table to match the characteristics to the correct logic families.

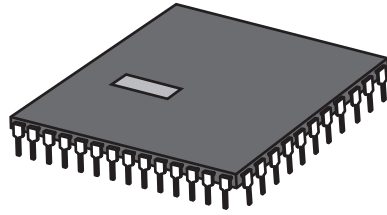| Characteristic	Logic Family	
	CMOS	**TTL**
Higher power consumption		✓
Larger fan out		
Easily damaged by static electricity		
Can use supply voltages between 3–18 volts		
Faster switching speeds		

(*e*) State the purpose of the dot on an IC.

_____

[Turn over

9. A microcontroller makes use of three types of memory.

(*a*) Complete the following table to describe the function and characteristic of the named microcontroller memories.

Name	Function	Characteristic
RAM	*Stores data required when running the program*	*Data will not remain when power is switched off*
ROM		
EEPROM		

9. **(continued)**

(*b*) State the **full name** of EEPROM.

_____

The I/O port is another sub-system of the microcontroller.

(*c*) Describe the **function** of the I/O port.
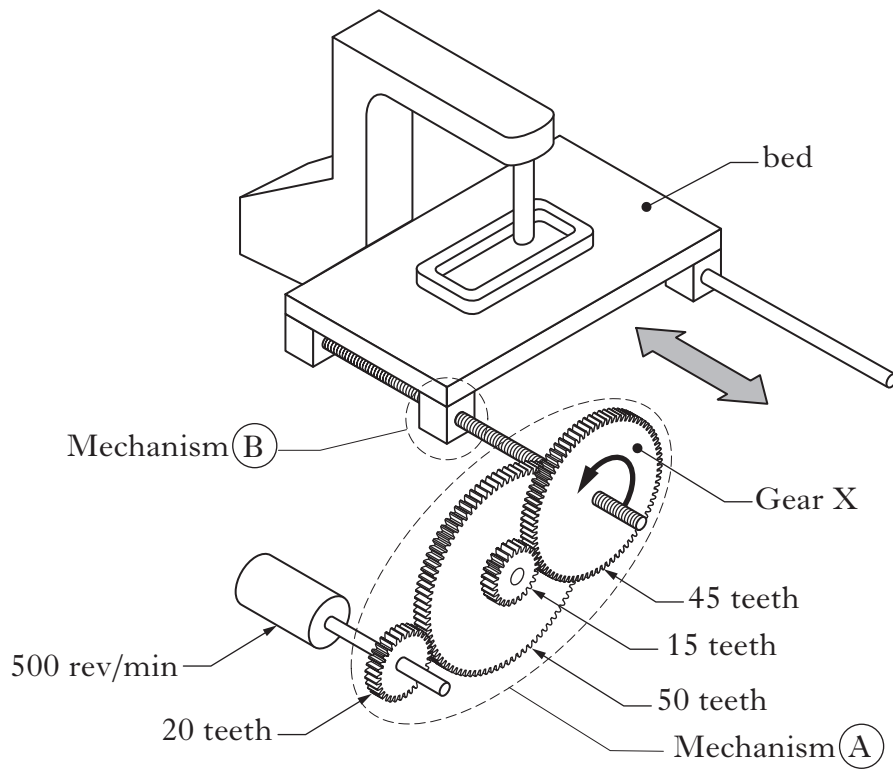
_____

_____

(*d*) Draw the shape of box required to jump to a sub-procedure.

(*e*) State the PBASIC command to set up pins 0–2 as inputs and pins 3–7 as outputs.

_____

[Turn over

10. The body of a mobile phone is machined by an automated system. One part is illustrated below.

(*a*) State the name of mechanism Ⓐ.

_____

(*b*) Calculate the speed of the gear X.

10. (continued)

The worm and nut (mechanism (B)) is used to convert rotational motion to linear motion. The worm has a pitch of 2 mm.

(*c*)   Calculate the linear speed of the bed when the worm rotates at 50 rev/min.

_____ m/s

(*d*)   Describe a change to the worm and nut mechanism that would **reduce** the output linear speed.

_____

_____

A flat belt is often used to transmit rotational motion in mechanical systems.

(*e*)   Describe **one** disadvantage of the flat belt.

_____

(*f*)   State the names of **two** further types of belt.

(i) _____   (ii) _____

(*g*)   State the name of a mechanism that will convert the following;

 (i) rotary to reciprocating motion.

_____

 (ii) linear to rotational motion.

_____

[*END OF QUESTION PAPER*]

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ACKNOWLEDGEMENTS