ENGINEERING SCIENCE

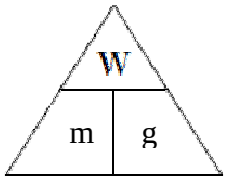
# N5 Prelim Revision Examples

Name _____

Class _____

Teacher _____

# Mass and Weight and Gravity




Weight (N) = mass (kg) x gravity (m/s$^2$)

Q1. "Mass and weight" are used in everyday language almost as if they were the same thing.
Using the information and table below, decide what information belongs to which column, and write it in:

is a force
measured in newtons
caused by the pull of gravity
same anywhere in the universe
not a force
measured in kilograms
is lower on the moon than on Earth

| Mass | Weight |
|---|---|
| | |
| | |
| | |
| | |
| | |

Weight is the force that pulls objects towards the centre of a planet. It depends on the mass of an object and the gravitational field strength of the planet. We can calculate weight using:

Weight (N) = mass (kg) X gravitational field strength (m/s$^2$)

Q2. a) "A bag of flour weighs one kilogram" Explain why this statement is not accurate.

b) Rewrite the above statement so that it is accurate.

Q4. The strength of gravity on Earth is g = 9.8 m/s$^2$. Find the weight of rocks with the following masses:

a) 5 kg b) 10 kg c) 2.5 kg

Find the mass of rocks with the following weights on Earth:

d) 30 N e) 150 N f) 450 N

Q5. The strength of gravity on the Moon is g = 1.6 $m/s^2$. Find the weight of moon rocks with the following masses:

a) 5 kg b) 10 kg c) 2.5 kg

Find the mass of rocks with the following weights on the Moon:

d) 16 N e) 80 N f) 960 N

**Q7.** Why does your weight change if you go to the Moon?

**Q9.** In outer space there is zero gravity. If your mass on Earth is 100 kg:

**a** what is your mass in space

**b** what is your weight in space?

DO NOT WRITE IN THIS MARGIN

*Marks*

**3.** Part of a logic diagram used in a child's toy is shown in Figure Q3(*a*).

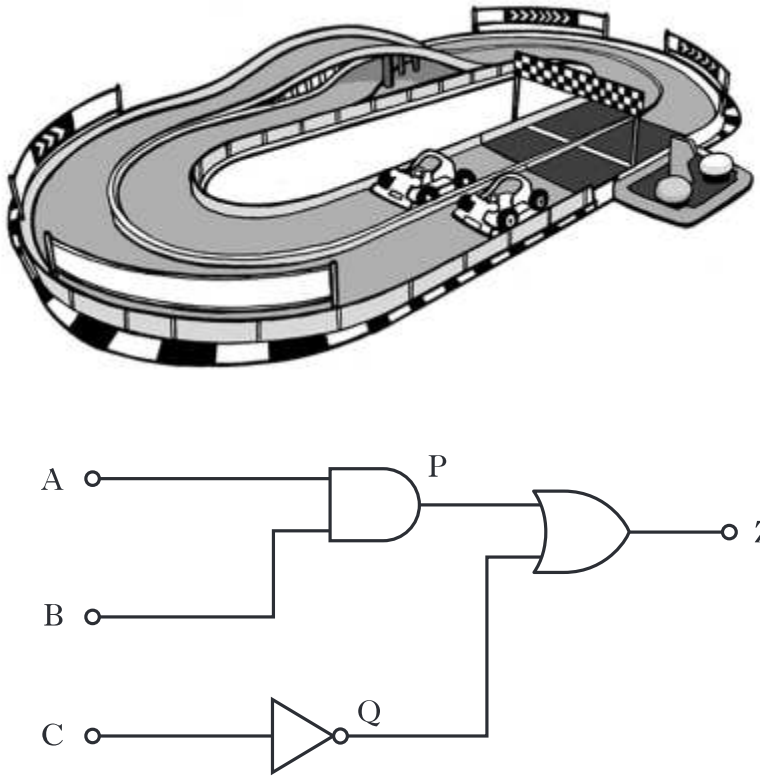



Figure Q3(*a*)

(*a*) Complete the truth table for the logic diagram shown in Figure Q3(*a*).

| A | B | C | P | Q | Z |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 0 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 0 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

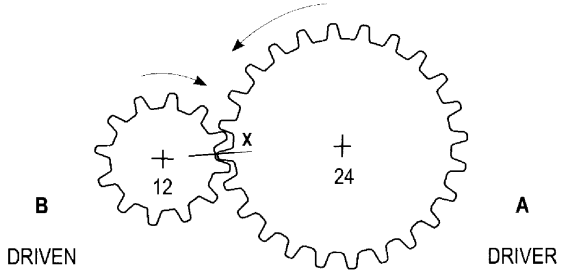
**3**

# Gears

Gears are toothed wheels designed to transmit rotary motion and power from one part of a mechanism to another. They are fitted to shafts with special devices called keys (or splines) that ensure that the gear and the shaft rotate together. Gears are used to increase or decrease the output speed of a mechanism and can also be used to change the direction of motion of the output.

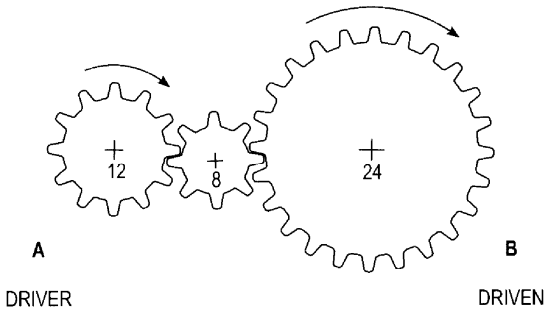
## Simple Gear Train

Gears work by interlocking or meshing the teeth of the gears together as shown. When 2 or more gears are meshed they form a **gear train**. The **input** gear which causes the system to move is called the **driver** and the **output** gear is called the **driven**.



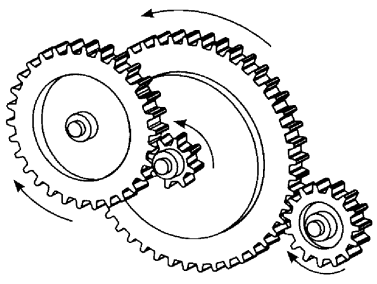

## Idler Gear

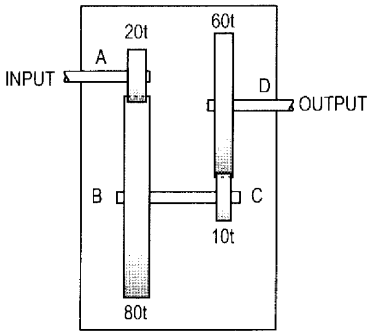
To get the driven gear to rotate in the same direction as the driver a third gear is inserted in the system. The idler gear has no effect on the speed of the driven gear wheel.




## Compound Gear Trains

If gears are required to produce a very large change in speed, for example 100:1 then problems can arise with the size of gear wheels if a simple gear train is used. The problem can be overcome by mounting pairs of gears on the same shaft as shown.





11. A prototype solar panel is being tested.

(a) Describe the role of the following engineers in the development of the panel.

(i) Type of engineer —Electronic Engineer 1

Role —_____

_____

(ii) Type of engineer —Mechanical Engineer 1

Role —_____

_____

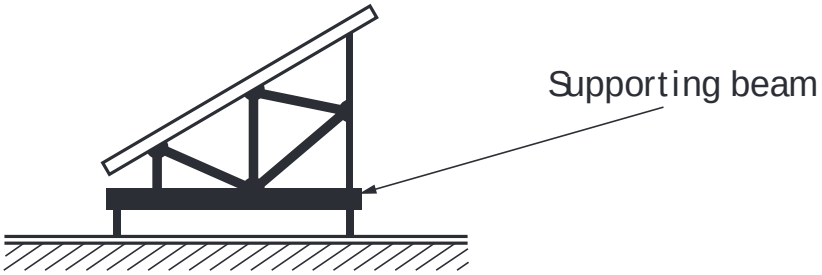
During testing, the panel absorbs 15 MJ of energy and is found to be 73% (0·73) efficient.

(b) Calculate the output electrical energy produced. 3

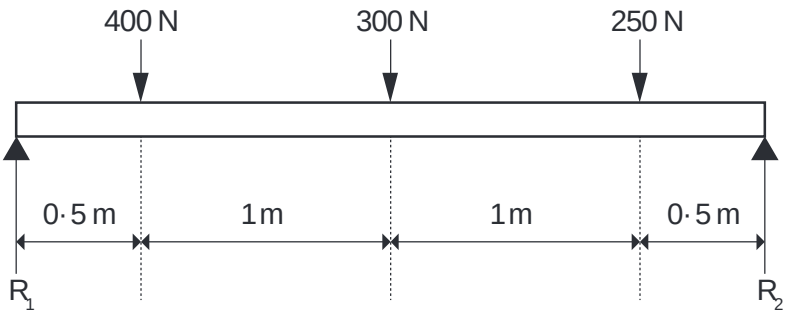
11. (continued)

(c) Explain how solar panels can contribute to tackling climate change. 2

The solar panels are fitted to a frame supported by a beam, as shown in the diagram below.



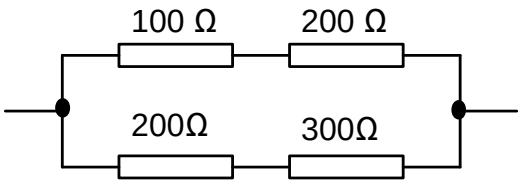

The forces acting on the beam are shown in the diagram below.



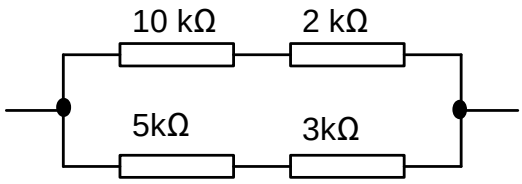

(d) Calculate the size of reaction force $R_2$ by taking moments about $R_1$. 3

Total Marks 10

1. Part of the circuitry in a power supply is shown below.




a) Calculate the combined resistance of the four resistors.




**b)** Calculate the combined resistance of the four resistors.

2. Describe three possible environmental impacts of constructing a new bridge over a river.

DO NOT WRITE IN THIS MARGIN

Marks

6. A circuit used to warn when a vehicle is reversing is shown in Figure Q6.

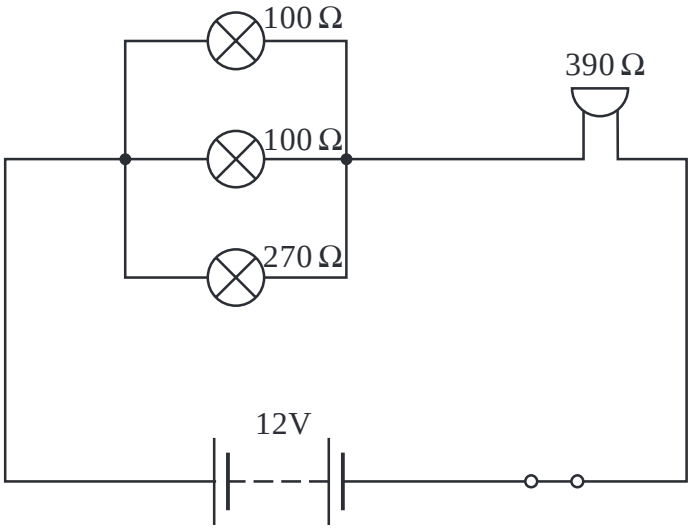



Figure Q6

(a) Calculate:

(i) the equivalent resistance of the three lamps;

3

(ii) the total circuit resistance;

1

(iii) the total circuit current;

2

DO NOT WRITE IN THIS MARGIN

Marks

6. (a) (continued)

(iv) the power used by the circuit.

2

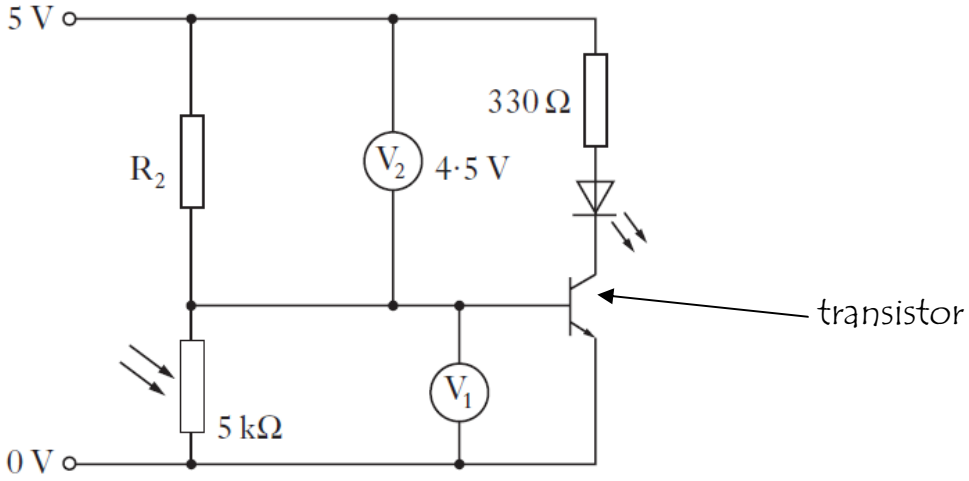
(b) Indicate on Figure Q6, with a cross (X), where an ammeter would be placed to measure the current through the 270 Ω lamp.

1

(9)

Task 15

Here shows an electronic circuit for a garden night light.




a) State with reference to the Data Booklet, the light level that will produce a resistance of 5 kΩ in the LDR.

b)Mark the transistor connections with b (base), c (collector), e (emitter).

For the conditions shown in the diagram

c) Determine the voltage shown on V1;

d) Calculate the resistance R2;

d) State if the LED is on or off, and explain why this is the case.

e) Describe the effect that an increasing light level will have on the resistance of the LDR and the voltage shown on V1.

*As the light level increases . . .*

DO NOT WRITE IN THIS MARGIN

Marks

2. A pneumatic circuit used in a production line is shown in Figure Q2.

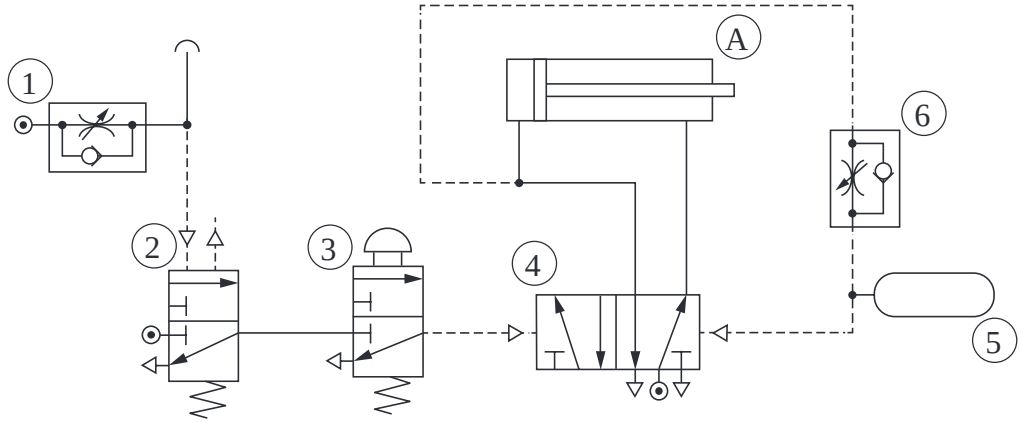



Figure Q2

(a) State the full name of the following pneumatic components.

Component (5) _____

Valve (2) _____ 2

(b) Describe, using appropriate terminology, the operation of the pneumatic circuit.

An increase in pressure is sensed . . .

_____

_____

_____

_____

_____ 4

The circuit shown in Figure Q2 uses AND control.

(c) (i) State the name of the pneumatic valve that is used to produce OR control.

_____ 1

(ii) Draw the symbol for this valve in the space below.

1

(8)

11. A pneumatic circuit for a stamping system to press mechanical parts out of a sheet of metal is shown in Figure Q11(a).

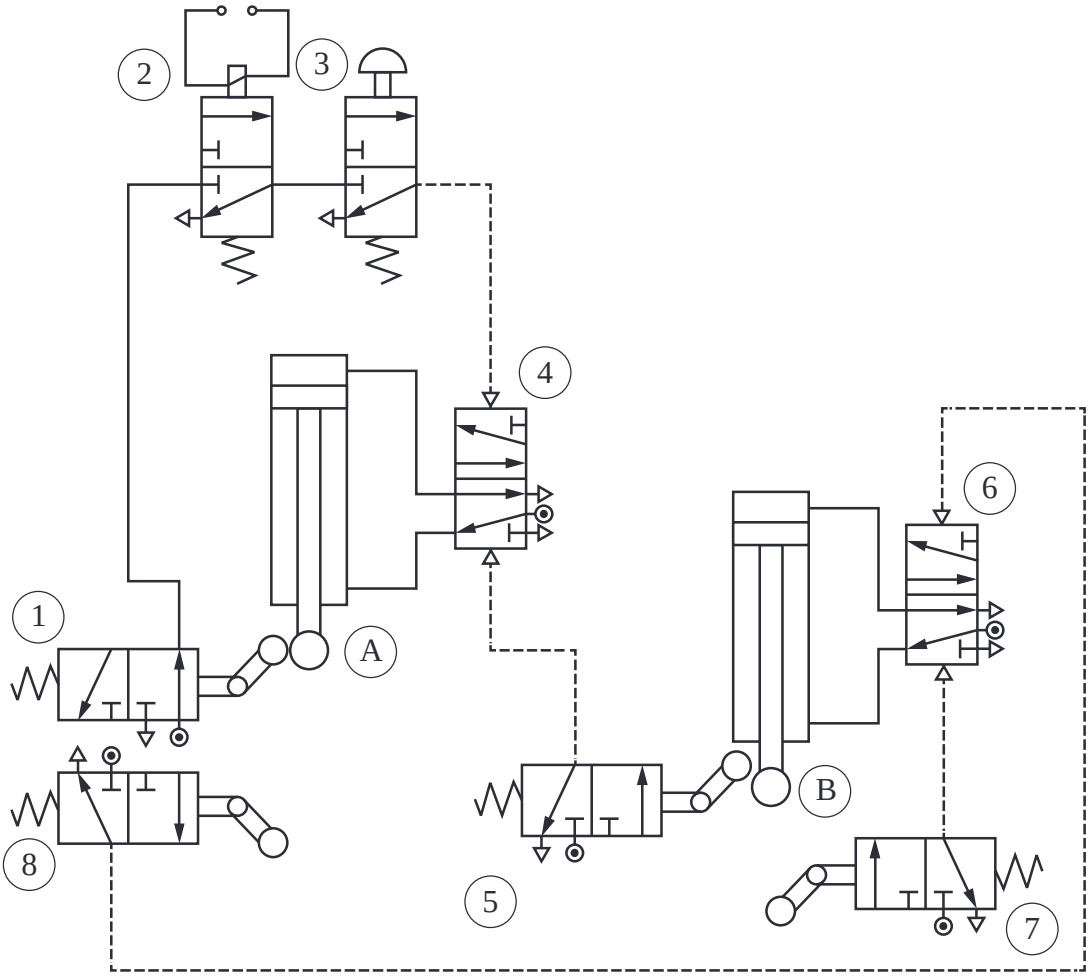



Figure Q11(a)

Marks

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11.

(a) (i) State the name of the actuator on the following valves.

(2) _____ , spring return

(3) _____ , spring return 2

(ii) State the type of control created by valves (2) and (3).

_____ 1

The pneumatic circuit shown in Figure Q11(a) uses sequential control.

(b) Describe what is meant by sequential control.

_____ 1

(c) Describe, using appropriate terminology, the operation of the stamping system.

When valve (2) is actuated _____

_____

_____

_____

_____

_____

_____

_____

_____ 6

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Marks

**2.** The double acting cylinder used to open and close a bus door is controlled by a 5/2, solenoid, spring return valve.

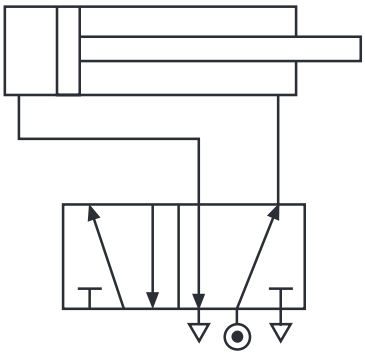

Figure Q2(*a*)

(*a*) (i) Complete Figure Q2(*a*) by adding the symbols for the solenoid and the spring actuators. **2**

(ii) Indicate on Figure Q2(*a*) (with an X) the exhaust port used when the piston **instrokes**. **1**

Figure Q2(*b*) shows the dimensions of the double acting cylinder.

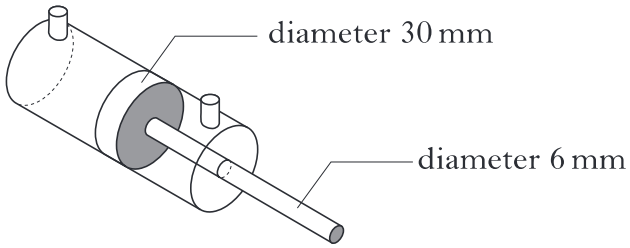


Figure Q2(*b*)

(*b*) Calculate:

(i) the effective area of the piston as it instrokes;

**3**

(ii) the instroking force of the piston if air is supplied at a pressure of 0·6 N/mm$^2$.

**2**

**(8)**

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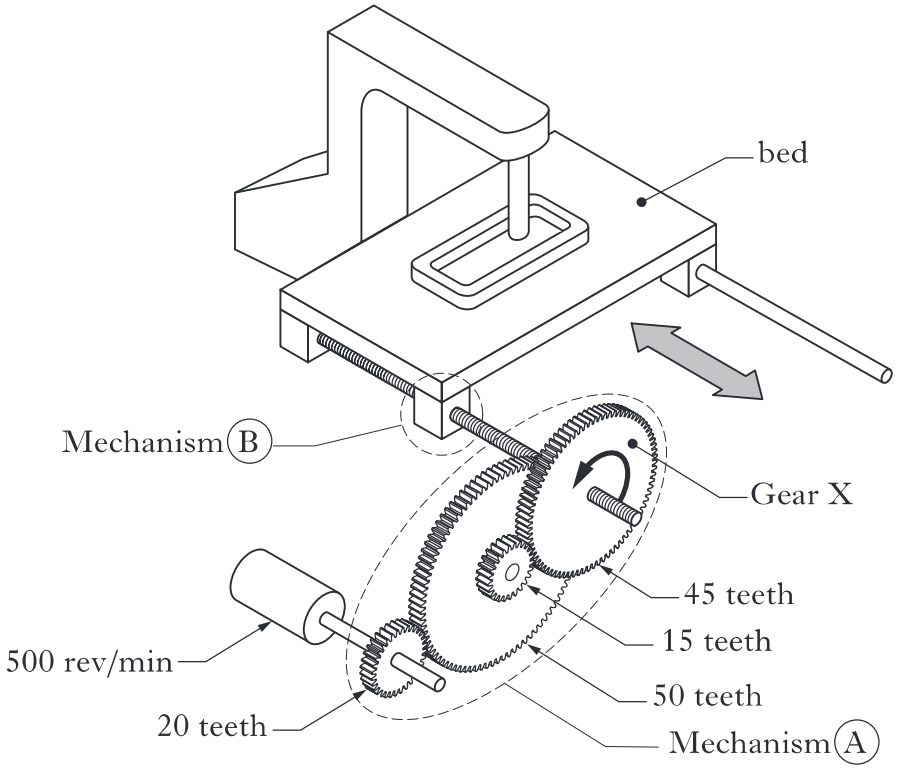
| KU | RNA |
|---|---|

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




(*a*) State the name of mechanism (A).

**1 0**

_____

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

**4 3 2 1 0**

**7.** A model railway uses a microcontroller to operate a barrier.

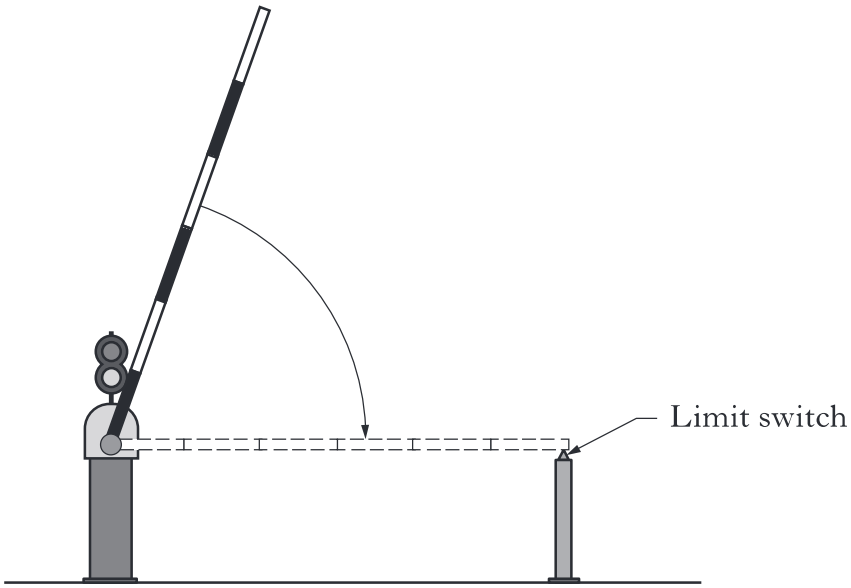



Figure Q7

The operation of the system is shown below.

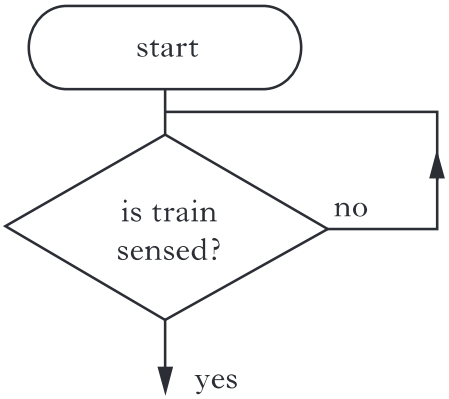
- When a train is sensed the barrier should lower.
- When a limit switch is pressed the barrier will stop.
- When the train is no longer sensed, wait for ten seconds.
- Barrier will rise.
- After three seconds the barrier will stop.
- Sequence will then repeat.

DO NOT WRITE IN THIS MARGIN

*Marks*

**7. (continued)**

Complete the flowchart for the barrier operation, with reference to the Data Booklet.




**(7)**

DO NOT WRITE IN THIS MARGIN

6. A microcontroller is used to operate a robotic arm.

The sequence of operation for the robotic arm is shown below.

Step 1 Check if start switch is pressed.

Step 2 When start switch is pressed arm moves forward.

Step 3 After two seconds the arm stops.

Step 4 Jump to the sub-procedure “gripper”.

Step 5 Once sub-procedure “gripper” is complete arm moves backward.

Step 6 After two seconds the arm stops.

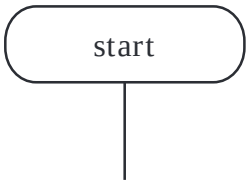
Step 7 Repeat 200 times steps two to six before resetting to step one.

DO NOT WRITE IN THIS MARGIN

Marks

6. (continued)

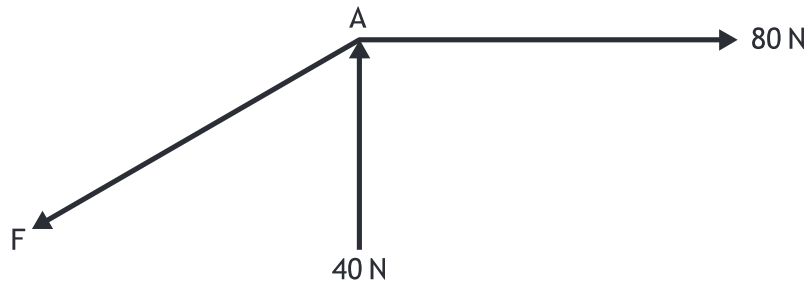
Complete, with reference to the Data Booklet, the flowchart for the robotic arm operation.



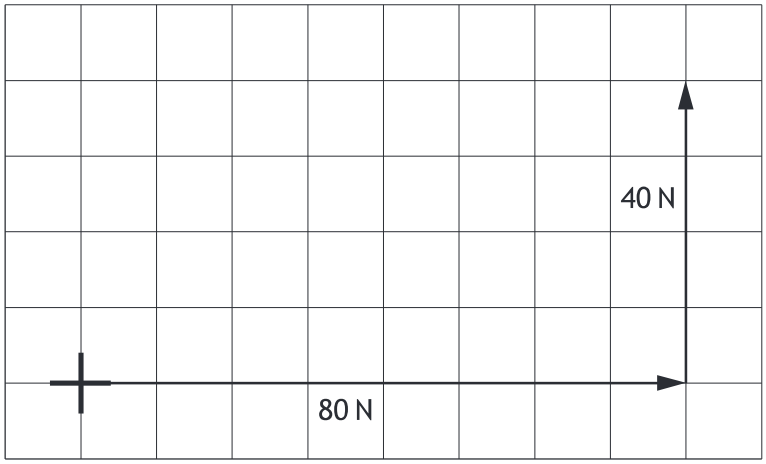

(8)

**14. (continued)**

During the design of the guitar, the designer needs to calculate the force F required to keep point A in equilibrium.



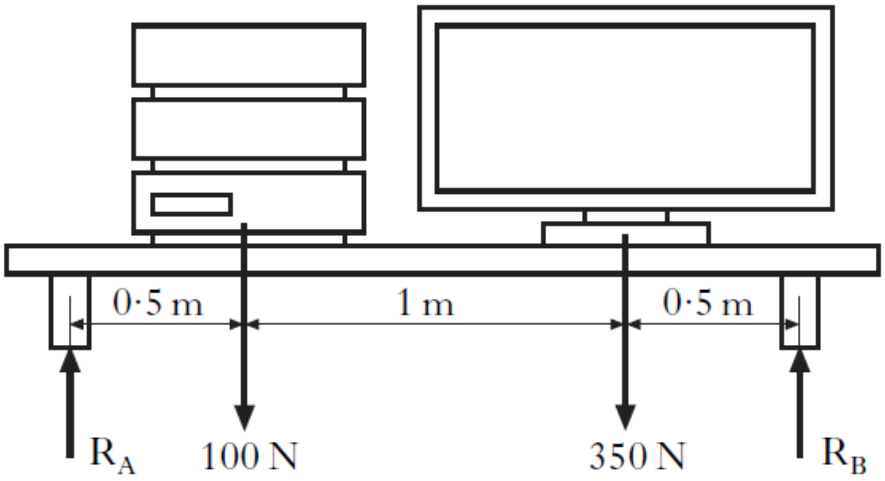

(c) Determine the size of force F using the scale drawing of the triangle of forces shown in the diagram below (or otherwise). **1**




F = _____ N

Task 7

A unit used to support the DVD player, an entertainment system and television is shown




a) Draw a free body diagram for the unit shown.

b) Calculate:

(i) the reaction force RA (take moments about RB);

(ii) the reaction force RB.

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SECTION B

Marks

Attempt any TWO questions (Total 40 marks)

9. Figure Q9 shows the circuit diagram for an automatic water heater.

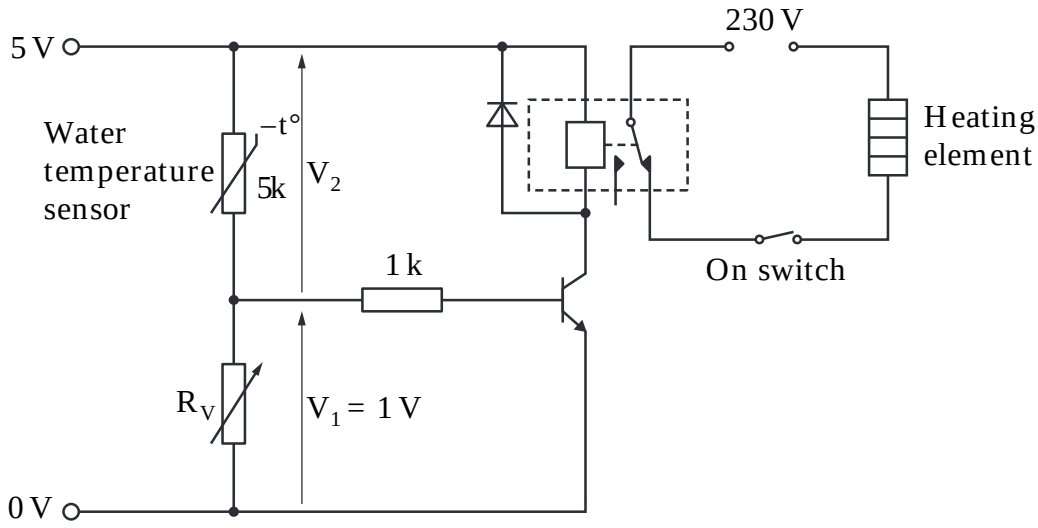


Figure Q9

(a) Describe, using appropriate terminology, the operation of the circuit when the on switch is pressed to heat the water.

When the on switch is pressed _____

_____

_____

_____

_____

_____

_____ 4

(b) A SPDT relay is used in the system.

(i) State the full name of this relay.

_____ 1

(ii) Explain why a relay is required to operate the heating element.

_____

_____ 1

DO NOT WRITE IN THIS MARGIN

Marks

9. (continued)

The system is set to heat water to 25 °C.

(c) Determine, with reference to the Data Booklet, the thermistor type used in the system if it has a resistance of 5 kΩ at 25 °C.

_____ 1

(d) State the function of the variable resistor in the circuit.

_____

_____ 1

When the transistor is saturated, $V_1$ is found to be 1 V.

(e) Calculate:

(i) the voltage $V_2$;

1

(ii) the resistance of the variable resistor $R_V$.

2

The 230V, 6 A heating element takes 20 minutes to heat 25 kg of water to 25 °C.

(f) Calculate:

(i) the electrical energy supplied to the heating element;

3

The government has been promoting the use of renewable sources of energy such as **wave, solar** and **hydro.**

Explain **one** disadvantage which must be considered when using each of these sources. **Each disadvantage may be used only once.**

Wave _____

_____

_____

_____

Solar _____

_____

_____

_____

Hydro _____

_____

_____

_____

**11. (continued)**

*Marks*

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The logic diagram for an alternative air freshener is shown in Figure Q11(*b*).

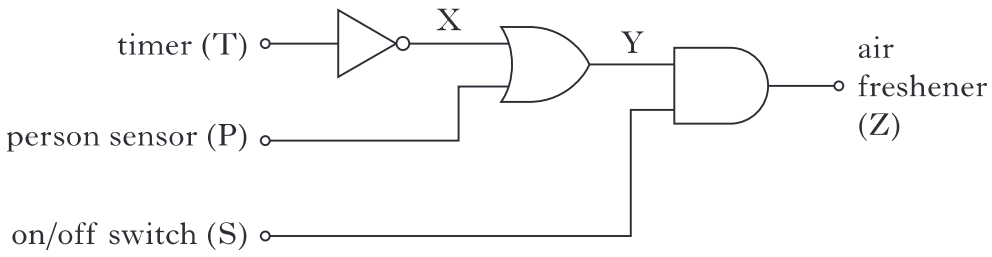


Figure Q11(*b*)

(*d*) State, with reference to Figure Q11(*b*), the Boolean expression for the air freshener (Z) in terms of T, P and S.

Z = _____ **3**

(*e*) Complete the truth table for the logic diagram shown in Figure Q11(*b*).

| S | P (1 = person sensed) | T (0 = timer on) | X | Y | Z |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 0 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 0 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

**3**

**2.** The logic diagram for a security system is shown in Figure Q2(*a*). *Marks*

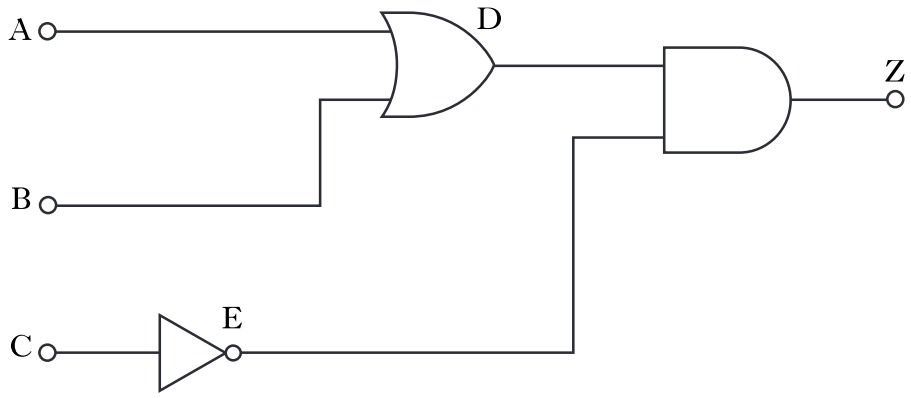


Figure Q2(*a*)

(*a*) With reference to the logic diagram shown in Figure Q2(*a*):

(i) write the Boolean expression for output Z in terms of inputs A, B and C;

Z = _____ **3**

(ii) complete the truth table below for the security system.

| A | B | C | D | E | Z |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 0 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 0 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

**3**

An LED is used in the security system to show when it is in operation.

(*b*) (i) Complete the circuit shown in Figure Q2(*b*) so that it will allow an LED to indicate when the security system is in operation.


Figure Q2(*b*) **2**

(ii) State the **function** of the resistor in the circuit.

_____ **1**

**(9)**