

**Numerical
Questions
for
Standard Grade
Physics**



L Robinson

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Note : *The questions in italic are considered to be more demanding.*

POWER AND ENERGY $E = P t$

30. Complete the following table:

	POWER	TIME	ENERGY
a)	100 W	5 s	-----
b)	-----	750 s	5×10^4 J
c)	25 mW	-----	5 J
d)	-----	3 ms	$7 \mu\text{J}$
e)	1.2 kW	5 min	-----
f)	50 W	-----	10^6 kJ
g)	-----	0.5 h	6.9×10^5 J

31. A capacitor stores 40 mJ and is discharged in 0.03 s. What power does it develop?
32. How much energy, in joules, is dissipated in 1 h by a 3 kW electric fire?
33. How long does it take to completely discharge a battery which stores 2×10^3 MJ and is used to power a 6 kW heater?
34. A 20 mW LED is run from a small battery which stores 50 kJ of energy. How long does it take the LED to use up all this energy?
35. A 12 V power supply is connected to an immersion heater. If it is used for 2.5 min and provides 9 kJ of energy, what is the power of the immersion heater?
36. How much energy, in joules, is used when three 100 W bulbs, an electric fire with two bars each 2 kW and a 600 W television are used for 6 h?
37. In general, which type of devices have the highest power ratings?
38. Suggest possible power ratings for the following mains appliances:
- a colour television set
 - a light bulb
 - an electric fire
 - a kettle
 - a cooker with 4 rings, a grill and an oven
 - a hair dryer

POWER, CURRENT AND VOLTAGE $P = IV$

39. Complete the following table:

	CURRENT	VOLTAGE	POWER
a)	2 A	-----	12 W
b)	-----	240 V	3×10^3 W
c)	25 mA	250 mV	-----
d)	-----	800 V	4×10^2 W
e)	$7 \mu\text{A}$	-----	0.00021 W
f)	3.2 mA	5 kV	-----
g)	-----	240 V	6.9×10^3 W

40. Calculate the power consumption of the following devices:

- a 2 V LED drawing 10 mA
- a mains lamp drawing 250 mA
- an electric kettle working from the mains taking 12.5 A
- a mains television set which takes 2.75 A

41. Calculate the current through the following devices:

- a mains heater rated at 2 kW
- a 250 W hair dryer which works from a 36 V battery
- an electric train with a power of 6 W running from a 12 V battery
- a transistor requiring 5 V and dissipating a power of 0.2 mW

42. Calculate the voltage required to run the following at their rated power level:

- a 1500 kW generator carrying 30 A
- a 5 mW diode carrying 0.00125 A
- a hair-dryer rated at 550 W carrying 4.6 A
- an immersion heater rated at 2.4 kW carrying 10 A

43. A 100Ω resistor carries a current of 2 A.

- Calculate the voltage across the resistor.
- Calculate the power dissipated in the resistor.

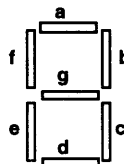
44. 400 kV is applied to a $50 \text{ M}\Omega$ resistor.

- Calculate the current in the resistor.
- Calculate the power dissipated in the resistor.

45. Show that $P = IV$ and $P = I^2R$ are equivalent.

OUTPUT DEVICES

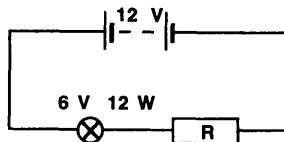
1. Draw a trace you could expect on an oscilloscope screen for:
 - a) an analogue signal,
 - b) a digital signal.
2. Devices can be analogue or digital. Classify the following input devices: microphone, switch, LDR, solar cell, capacitor, thermocouple, thermistor.
3. Devices can be analogue or digital. Classify the following output devices: motor, relay, solenoid, buzzer, loudspeaker, LED, 7-segment display.
4. State which output device you would use in the following situations:
 - a) to broadcast the results of a race to the crowd at the track
 - b) to show that a piece of equipment is on
 - c) to display the time
 - d) in the central locking of a car
5. State which output device you would use in the following situations:
 - a) to record your voice
 - b) to set a motor running when it gets cold
 - c) to set a time delay on pedestrian lights
 - d) to tell when it gets dark
6. In a seven segment display, the segments are as shown.
 - a) State which segments are lit up to show the following numbers:
 - i) 4
 - ii) 7
 - iii) 1
 - iv) 2
 - b) What number is shown when segments a, b, c, d, g are lit?



PROTECTIVE RESISTORS

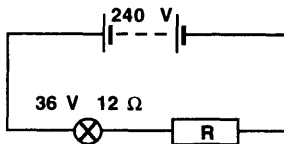
7. An LED takes 10 mA and 1.5 V to work correctly. What value of series resistor is required if a 6 V battery is used?
8. An LED takes 15 mA and 2 V to work correctly. What value of series resistor is required if a 12 V battery is used?
9.
 - a) An LED takes 10 mA and 2 V to work correctly. What value of series resistor is required if a 20 V supply is used?
 - b) Draw a circuit diagram showing how the resistor, LED and supply are connected.

10. A 6 V, 12 W light bulb has to be run, at its normal rating, from a 12 V supply as shown.



- a) Calculate the current through the bulb.
b) Calculate the voltage across the resistor.
c) Calculate the value of the resistor.
11. A 20 V supply is used with an 8 V, 24 W motor and therefore needs a protective resistor.
a) Calculate the current through the motor.
b) Calculate the voltage across the resistor.
c) Calculate the resistance required.
12. A 120 V, 60 W motor is used with a 240V supply.
Calculate the value of the resistor which should be used to run it at its normal rating.

13. A 240 V supply is used to run a 36 V, 18 Ω bulb as shown.

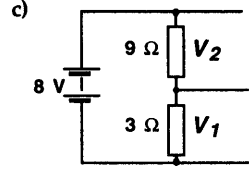
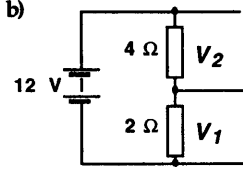
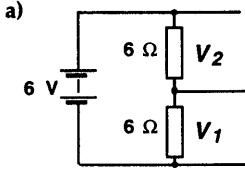


- a) Calculate the current through the bulb.
b) Calculate the voltage across the resistor.
c) Calculate the value of the resistor.
14. A 1.5 V cell is used with a 300 mV, 75 Ω component.
What protective resistor is required?
15. A 12 V supply is used with a 3 V, 6 W bulb. In order to protect it a 3 Ω resistor has been placed in series.
What additional series resistance would be needed to protect the bulb properly?
16. A 500 V supply gives a current of 5 A for a large motor. The motor has a resistance of 95 Ω .
a) Explain why a protective resistor is required.
b) Calculate the value.
17. An LED requires 10^{-2} A and 3.2 V to work correctly.
a) What protective resistor is required with a 9 V supply?
b) Calculate the resistance of the LED.
c) Calculate the power rating of the LED.

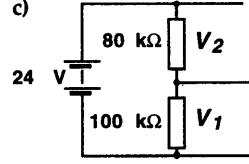
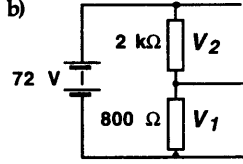
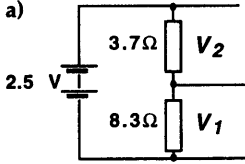
VOLTAGE DIVIDERS

$$V_{R_1} = \frac{R_1}{R_{total}} \times V_{supply}$$

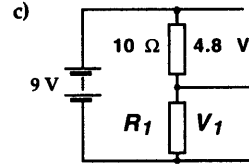
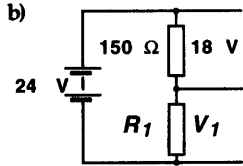
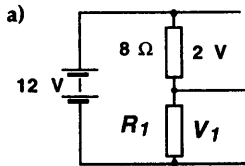
18. Find the voltages V_1 and V_2 in the following circuits:



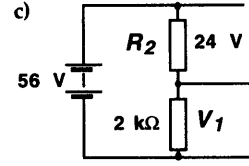
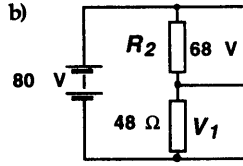
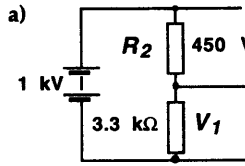
19. Find the voltages V_1 and V_2 in the following circuits:



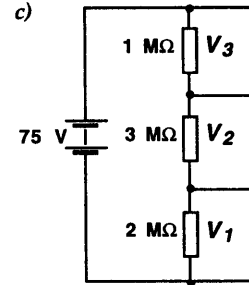
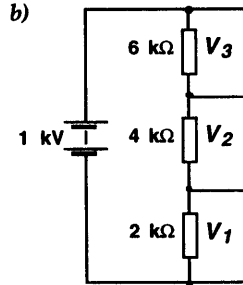
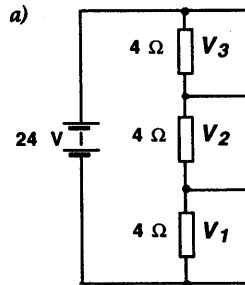
20. Find the resistance R_1 and the voltage V_1 in the following circuits:



21. Find the resistance R_2 and the voltage V_1 in the following circuits:

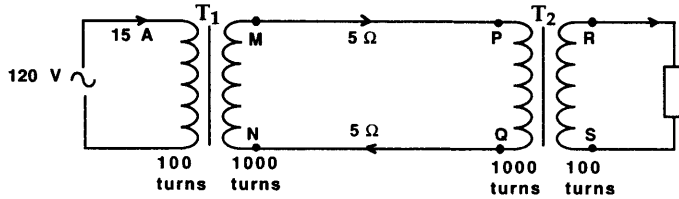


22. Find the voltages V_1, V_2 and V_3 in the following circuits:



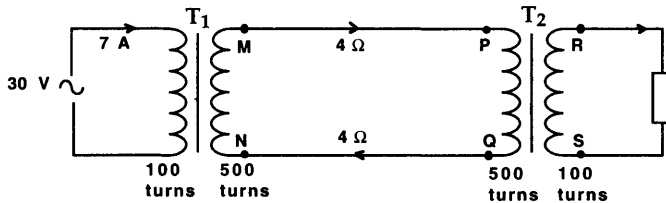
TRANSMISSION LINES (Assume 100% efficiency for all transformers.)

76.



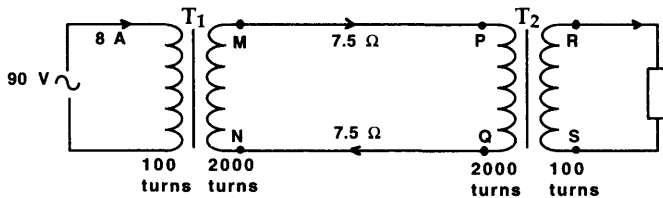
- Calculate the voltage across MN.
- Calculate the current in MPQN.
- Calculate the voltage across MP and QN.
- Calculate the power loss in both transmission lines.
- Calculate the voltage across PQ.
- Calculate the voltage across RS.
- Calculate the current through the resistor in the secondary of T_2 .
- What is the resistance of the resistor?

77.



- Calculate the voltage across MN.
- Calculate the current in MPQN.
- Calculate the voltage across MP and QN.
- Calculate the power loss in both transmission lines.
- Calculate the voltage across PQ.
- Calculate the voltage across RS.
- Calculate the current through the resistor in the secondary of T_2 .
- What is the resistance of the resistor?

78.



- Calculate the voltage across MN.
- Calculate the current in MPQN.
- Calculate the voltage across MP and QN.
- Calculate the power loss in both transmission lines.
- Calculate the voltage across PQ.
- Calculate the voltage across RS.
- Calculate the current through the resistor in the secondary of T_2 .
- What is the resistance of the resistor?

HEAT ENERGY (no change of state) $E_h = c m \Delta T$

79. Complete the following table:

	c	m	ΔT	E_h
a)	4180 J kg ⁻¹ °C ⁻¹	2 kg	80 °C	-----
b)	900 J kg ⁻¹ °C ⁻¹	1.5 kg	-----	337 500 J
c)	-----	8 kg	120 °C	384 000 J
d)	130 J kg ⁻¹ °C ⁻¹	-----	88 °C	2860 J
e)	2100 J kg ⁻¹ °C ⁻¹	250 g	15 °C	-----
f)	-----	50 mg	65 °C	7.5 J
g)	720 J kg ⁻¹ °C ⁻¹	-----	225 °C	165 MJ
h)	3300 J kg ⁻¹ °C ⁻¹	800 g	-----	37 kJ

In the following questions assume there is no heat loss unless otherwise stated.

Use the following heat capacities:

water	4180 J kg ⁻¹ °C ⁻¹
methylated spirits	2300 J kg ⁻¹ °C ⁻¹
aluminium	880 J kg ⁻¹ °C ⁻¹
copper	380 J kg ⁻¹ °C ⁻¹
lead	130 J kg ⁻¹ °C ⁻¹

80. Calculate the heat energy which is required to raise the temperature of:
- 4 kg of water from 10 °C to 20 °C,
 - 100 g of aluminium from 100 °C to 500 °C,
 - 1.5 kg of copper by 100 °C,
 - 50 g of lead from 50 °C to 450 °C.
81. Calculate the rise in temperature when 10 000 J are supplied to:
- 2 kg of water,
 - 2.5 kg of aluminium,
 - 600 g of copper,
 - 1.5 kg of methylated spirits.
82. Calculate the mass of material which is present if 20 000 J of energy produces a rise in temperature of 20 °C in:
- water,
 - aluminium,
 - copper,
 - lead.