Numerical Questions for Standard Grade Physics

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CONTENTS

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

POWER AND ENERGY $E = Pt$

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 μJ
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) a colour television set
    b) a light bulb
    c) an electric fire
    d) a kettle
    e) a cooker with 4 rings, a grill and an oven
    f) a hair dryer

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

41. Calculate the current through the following devices:
- **a)** a mains heater rated at 2 kW
- **b)** a 250 W hair dryer which works from a 36 V battery
- **c)** an electric train with a power of 6 W running from a 12 V battery
- **d)** 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)** a 1500 kW generator carrying 30 A
- **b)** a 5 mW diode carrying 0.00125 A
- **c)** a hair-dryer rated at 550 W carrying 4.6 A
- **d)** an immersion heater rated at 2.4 kW carrying 10 A

43. A 100 Ω resistor carries a current of 2 A.
- **a)** Calculate the voltage across the resistor.
- **b)** Calculate the power dissipated in the resistor.

44. 400 kV is applied to a 50 MΩ resistor.
- **a)** Calculate the current in the resistor.
- **b)** Calculate the power dissipated in the resistor.

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

ELECTRONICS

OUTPUT DEVICES

1. Draw a trace you could expect on an oscilloscope screen for:
   a) an analogue signal,
   b) a digital signal.

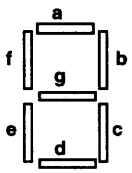
2. Devices can be analogue or digital. Classify the following input devices: microphone, switch, LDR, solar cell, capacitor, thermocouple, thermistor.

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?



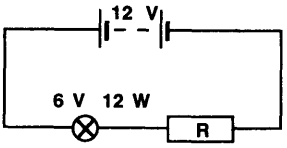
PROTECTIVE RESISTORS

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.

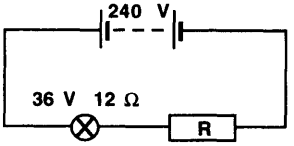


a) Calculate the current through the bulb.
b) Calculate the voltage across the resistor.
c) Calculate the value of the resistor.

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.

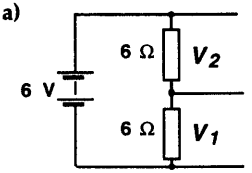
17. *An LED requires 10^{-2} A and 3.2 V to work correctly.*
a) What protective resistor is required with a 9 V supply?
b) Calculate the resistance of the LED.
c) Calculate the power rating of the LED.

VOLTAGE DIVIDERS

$$V_{R1} = \frac{R_1}{R_{total}} \times V_{supply}$$

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

a)



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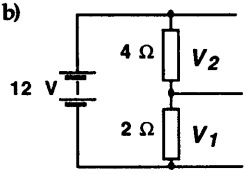

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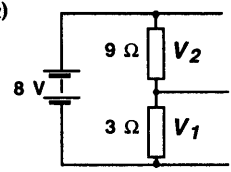
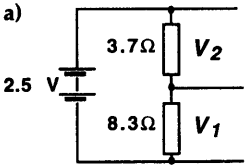
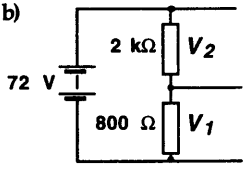


19. Find the voltages V_1 and V_2 in the following circuits:

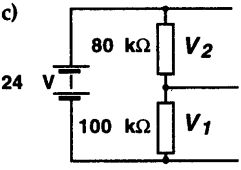
a)



b)

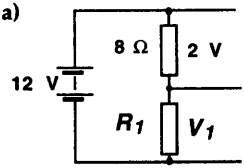


c)

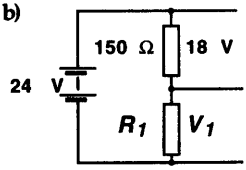


20. Find the resistance R_1 and the voltage V_1 in the following circuits:

a)



b)



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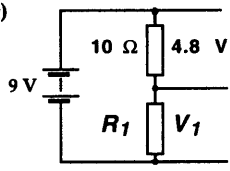
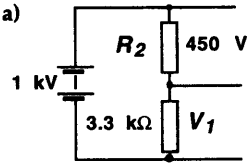
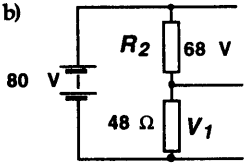


21. Find the resistance R_2 and the voltage V_1 in the following circuits:

a)



b)



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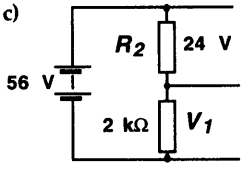
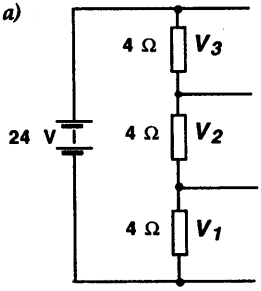
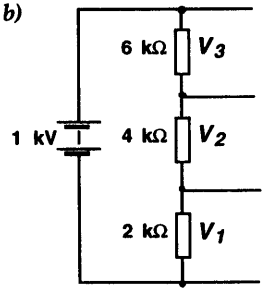


22. *Find the voltages V_1, V_2 and V_3 in the following circuits:*

a)



b)



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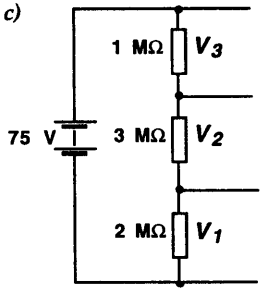
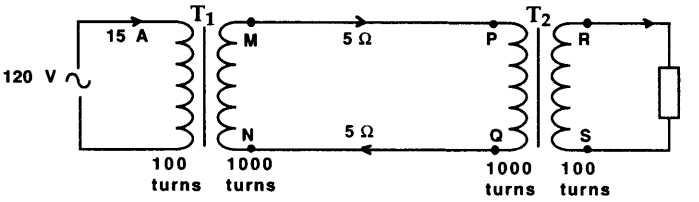


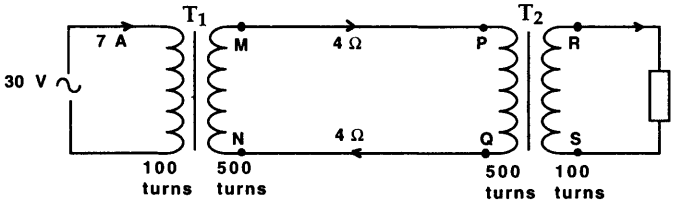
TRANSMISSION LINES (Assume 100% efficiency for all transformers.)

76.



a) *Calculate the voltage across MN.*
b) *Calculate the current in MPQN.*
c) *Calculate the voltage across MP and QN.*
d) *Calculate the power loss in both transmission lines.*
e) *Calculate the voltage across PQ.*
f) *Calculate the voltage across RS.*
g) *Calculate the current through the resistor in the secondary of T_2.*
h) *What is the resistance of the resistor?*

77.



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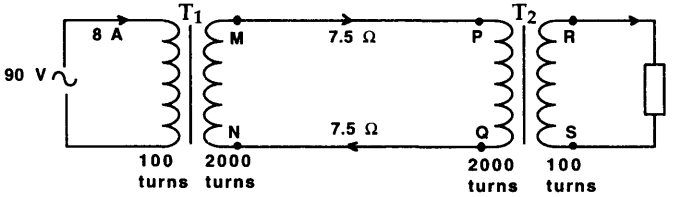

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h) *What is the resistance of the resistor?*

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:
- **a)** 4 kg of water from 10 °C to 20 °C,
- **b)** 100 g of aluminium from 100 °C to 500 °C,
- **c)** 1.5 kg of copper by 100 °C,
- **d)** 50 g of lead from 50 °C to 450 °C.

81. Calculate the rise in temperature when 10 000 J are supplied to:
- **a)** 2 kg of water,
- **b)** 2.5 kg of aluminium,
- **c)** 600 g of copper,
- **d)** 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:
- **a)** water,
- **b)** aluminium,
- **c)** copper,
- **d)** lead.