

Revision test 1 (Page 109)

This assignment covers the material contained in chapters 3 to 6

Problem 1. An electromagnet exerts a force of 15 N and moves a soft iron armature through a distance of 12 mm in 50 ms. Determine the power consumed.

	<u>Marks</u>
Work done = Work done = force $\times$ distance = $15 \text{ N} \times 12 \times 10^{-3} \text{ m} = 0.18 \text{ N m}$ or 0.18 J	2
Power consumed = $\frac{\text{work done}}{\text{time taken}} = \frac{0.18 \text{ J}}{50 \times 10^{-3} \text{ s}} = 3.6 \text{ J/s}$ or 3.6 W	3
Total:	5

Problem 2. A d.c. motor consumes 47.25 MJ when connected to a 250 V supply for 1 hour 45 minutes. Determine the power rating of the motor and the current taken from the supply.

	<u>Marks</u>
Power = $\frac{\text{energy}}{\text{time}} = \frac{47.25 \times 10^6 \text{ J}}{105 \times 60 \text{ s}} = 7500 \text{ W}$	
i.e. power rating of motor is 7.5 kW	3
Power $P = VI$ from which, current $I = \frac{P}{V} = \frac{7500}{250} = 30 \text{ A}$	
i.e. the current taken from the supply is 30 A	2
Total:	5

Problem 3. A 100 W electric light bulb is connected to a 200 V supply. Calculate (a) the current flowing in the bulb, and (b) the resistance of the bulb.

	<u>Marks</u>
Power P = (a) Power $P = VI$ from which, current $I = \frac{P}{V} = \frac{100}{200} = 0.5 \text{ A}$	2
Resistance (b) Resistance $R = \frac{V}{I} = \frac{200}{0.5} = 400 \Omega$	2
Work done = Total:	4

Problem 4. Determine the charge transferred when a current of 5 mA flows for 10 minutes.

	<u>Marks</u>
Charge, $Q = I \times t = 5 \times 10^{-3} \times 10 \times 60 = 3 \text{ C}$	2
Work done = Total:	2

Problem 5. A current of 12 A flows in the element of an electric fire of resistance 25Ω . Determine the power dissipated by the element. If the fire is on for 5 hours every day, calculate for a one week period (a) the energy used, and (b) cost of using the fire if electricity cost 13.5p per unit.

	<u>Marks</u>
Power dissipated $P = I^2 R = (12)^2 (25) = 3600 \text{ W}$ or 3.60 kW	2
(a) Energy = power $\times$ time = (3.60 kW)(5 $\times$ 7 h) = 126 kWh	2
(b) 1 unit of electricity = 1 kWh, hence cost = 126 $\times$ 13.5 = 1701p or £17.01	2
Total:	6

Problem 6. Calculate the resistance of 1200 m of copper cable of cross-sectional area 15 mm^2 . Take the resistivity of copper as $0.02 \mu\Omega\text{m}$.

Power P = Resistance, $R = \frac{\rho l}{a} = \frac{(0.02 \times 10^{-6} \Omega\text{m})(1200 \text{ m})}{15 \times 10^{-6} \text{ m}} = 1.60 \Omega$ Total:	<u>Marks</u>
	5

Problem 7. At a temperature of 40°C , an aluminium cable has a resistance of 25Ω . If the temperature coefficient of resistance at 0°C is $0.0038/^\circ\text{C}$, calculate its resistance at 0°C .

Resistance at $\theta^\circ\text{C}$, $R_\theta = R_0(1 + \alpha_0 \theta)$	<u>Marks</u>
Hence, resistance at 0°C, $R_0 = \frac{R_\theta}{(1 + \alpha_0 \theta)} = \frac{25}{1 + (0.0038)(40)} = \frac{25}{1.152} = 21.70 \Omega$ Total:	1

Problem 8.(a) Determine the values of the resistors with the following colour coding:

(i) red-red-orange-silver (ii) orange-orange-black-blue-green

(b) What is the value of a resistor marked as 47KK ?

(a) (i) red-red-orange-silver = $22 \times 10^3 \Omega$ with a tolerance $\pm 10\%$ i.e. 22 kΩ with a tolerance $\pm 10\%$ (ii) orange-orange-black-blue-green = $330 \times 10^6 \Omega$ with a tolerance $\pm 0.5\%$ i.e. 330 MΩ with a tolerance $\pm 0.5\%$ (b) 47KK = 47 kΩ with a tolerance of $\pm 10\%$ Total:	<u>Marks</u>
	2
	2
	2
	6

Problem 9. Four cells, each with an internal resistance of $0.40\ \Omega$ and an e.m.f. of $2.5\ \text{V}$ are connected in series to a load of $38.4\ \Omega$. (a) Determine the current flowing in the circuit and the p.d. at the battery terminals. (b) If the cells are connected in parallel instead of in series, determine the current flowing and the p.d. at the battery terminals.

	<u>Marks</u>
(a) When connected in series, total e.m.f., $E = 4 \times 2.5 = 10\ \text{V}$ and the total internal resistance, $r = 4 \times 0.40 = 1.60\ \Omega$ Hence, current flowing $I = \frac{E}{R_T} = \frac{10}{38.40 + 1.60} = \frac{10}{40} = \mathbf{0.25\ \text{A}}$ P.d. at battery terminals $V = E - Ir = 10 - (0.25)(1.60)$ $= 10 - 0.40 = \mathbf{9.60\ \text{V}}$	3 2
(b) When connected in parallel, total e.m.f., $E = \text{e.m.f. of one cell} = 2.5\ \text{V}$ and total internal resistance of four cells, $r = \frac{1}{4} \times \text{internal resistance of one cell} = \frac{1}{4} \times 0.40 = 0.10\ \Omega$ Hence current flowing $I = \frac{E}{R_T} = \frac{2.5}{38.40 + 0.10} = \frac{2.5}{38.50} = \mathbf{0.0649\ \text{A}} \text{ or } \mathbf{64.9\ \text{mA}}$ P.d. at battery terminals $V = E - Ir = 2.5 - (0.0649)(0.1) = \mathbf{2.494\ \text{V}}$ Total:	3 2 10

Problem 10. (a) State six typical applications of primary cells. (b) State six typical applications of secondary cells. (c) State the advantages of a fuel cell over a conventional battery and state three practical applications.

	<u>Marks</u>
(a) Any six from: torches, transistor radios, bells, indicator circuits, gas lighters, controlling switch-gear, hearing aids, medical electronics, cameras, guided missiles	3
(b) Any six from: car batteries, telephone circuits, milk delivery vans, fork lift trucks, marine work, lighting in railway carriages, military portable radios, starting diesel and petrol engines	3
(c) A fuel cell is an electrochemical energy conversion device, similar to a battery, but differing from the latter in that it is designed for continuous replenishment of the reactants consumed, i.e. it produces electricity from an external source of fuel and oxygen, as opposed to the limited energy storage capacity of a battery. Also, the electrodes within a battery react and change as a battery is charged or discharged, whereas a fuel cells' electrodes are catalytic (i.e. not permanently changed) and relatively stable. Typical reactants used in a fuel cell are hydrogen on the anode side and oxygen on The cathode side (i.e. a hydrogen cell). Usually, reactants flow in and reaction products flow out. Virtually continuous long-term operation is feasible as long as these flows are maintained. A fuel cell running on hydrogen can be compact, lightweight and has no moving parts. Fuel cells are very attractive in modern applications for their high efficiency and ideally emission-free use, in contrast to currently more modern fuels such as methane or natural gas that generate carbon dioxide. The only by-product of a fuel cell operating on pure hydrogen is water vapour Any three applications of fuel cells from :	3

power sources in remote locations, such as spacecraft, remote weather stations, fuel cell vehicles and in certain military applications.	3
Total:	12

Problem 11. State for lithium-ion batteries (a) three typical practical applications
(b) four advantages compared with other batteries
(c) three limitations

	<u>Marks</u>
(a) Applications include: consumer electronics, for military use, for battery electric vehicles, aerospace applications, golf carts or utility vehicles, electric tools, medical equipment Any three, 1 mark each	3
(b) Advantages of lithium-ion batteries 1. High energy density - potential for yet higher capacities. 2. Does not need prolonged priming when new 3. Relatively low self-discharge - self-discharge is less than half that of nickel-based batteries. 4. Low Maintenance - no periodic discharge is needed; there is no memory. 5. Speciality cells can provide very high current to applications such as power tools. Any four, 1 mark each	4
(c) Limitations of lithium-ion batteries 1. Requires protection circuit to maintain voltage and current within safe limits. 2. Subject to aging, even if not in use 3. Expensive to manufacture - about 40% higher in cost than nickel-cadmium. 4. Not fully mature - metals and chemicals are changing on a continuing basis. Any three, 1 mark each Total:	3 10

Problem 12. Name six alternative, renewable energy sources and give a brief description of each.

	<u>Marks</u>
1. Solar energy is one of the most resourceful sources of energy for the future. Solar energy could be used to run cars, power plants and space ships. Solar panels on roofs capture heat in water storage systems. Photovoltaic cells, when suitable positioned, convert sunlight to electricity.	3
2. Wind power is another alternative energy source that can be used without producing by-products that are harmful to nature. The fins of a windmill rotate in a vertical plane which is kept vertical to the wind by means of a tail fin and as wind flow crosses the blades of the windmill it is forced to rotate and can be used to generate electricity. Like solar power, harnessing the wind is highly dependent upon weather and location.	3
3. Hydroelectricity is achieved by the damming of rivers and utilising the potential Energy in the water. As the water stored behind a dam is released at high pressure, its kinetic energy is transferred onto turbine blades and used to generate electricity. The system has enormous initial costs but has relatively low maintenance costs and provides power quite cheaply.	3
4. Tidal power utilises the natural motion of the tides to fill reservoirs which are then slowly discharged through electricity-producing turbines.	3
5. Geothermal energy is obtained from the internal heat of the planet and can be used to generate steam to run a steam turbine which, in turn, generates electricity. The radius of the Earth is about 4000 miles with an internal core temperature of around 4000°C at the centre. Drilling 3 miles from the surface of the Earth, a temperature of 100°C is encountered; this is sufficient to boil water to run a steam-powered electric power plant. Volcanic features called geothermal hotspots are found all around the world which transmit excess internal heat from the interior of the Earth to the outer crust which can be used to generate electricity.	3
6. Biomass is fuel that is developed from organic materials, a renewable and sustainable source of energy used to create electricity or other forms of power. Some examples of materials that make up biomass fuels are scrap lumber, forest debris, certain crops,	

manure and some types of waste residues. With a constant supply of waste – from construction and demolition activities, to wood not used in papermaking, to municipal solid waste – green energy production can continue indefinitely.	
Total:	3 18

Problem 13. For solar power, briefly state (a) seven advantages (b) five disadvantages

	<u>Marks</u>
(a) Advantages of solar power 1. No pollution is created in the process of generating electricity. 2. Solar energy does not require any fuel. 3. Solar energy does not pollute air by releasing carbon dioxide, nitrogen oxide, sulphur dioxide or mercury into the atmosphere like many traditional forms of electrical generation does. 4. Solar energy does not contribute to global warming, acid rain or smog. It actively contributes to the decrease of harmful green house gas emissions. 5. There is no on-going cost for the power solar energy generates, as solar radiation is free everywhere; once installed, there are no recurring costs. 6. Can be flexibly applied to a variety of stationary or portable applications. 7. Is unaffected by the supply and demand of fuel and is therefore not subjected to the ever-increasing price of fossil fuel. See further advantages on page XX of textbook (b) Disadvantages of solar power 1. The initial cost of installing a solar energy system, largely because of the high cost of the semi-conducting materials used in building solar panels. 2. The cost is high compared to non-renewable utility-supplied electricity. 3. Solar panels require quite a large area for installation to achieve a good level of efficiency. 4. The efficiency of the system also relies on the location of the sun	Any seven, 1 mark each 7

5. The production is influenced by the presence of clouds or pollution in the air. Similarly, no solar energy will be produced during the night	5
Total:	12

Total Marks for Revision Test 1: 100
