O Level Combined Physics Structured

Practical Electricity Test 3.0

Q1

An air conditioner and a television are both connected to the same electrical circuit with a 240 V a.c. power supply.

Fig. 13.1 gives the normal rating and daily usage for the two electrical appliances.

Electrical Appliance	Normal Rating		Daily Usage
	Power	Voltage	
Air Conditioner	2300 W	240 V	8 hours
Television	280 W	240 V	4 hours

Fig. 13.1

(a) Calculate the total current through the main branch of the electrical circuit.

Total current = ...A [2]

(b) Fuses are normally rated at 1 A, 2 A, 5 A, 10 A, and 13 A. Suggest a suitable rating for the fuse to be fitted to the main branch of the electrical circuit. Explain your choice.

.....

.....

.....

[2]

(c) Describe a possible electrical hazard when the main branch of the electrical circuit is not fitted with a fuse.

.....

.....

[1]

(d) Given that the use of electricity is charged at $0.12 per unit, calculate the weekly cost incurred by the two electrical appliances.

cost = ...[2]

(e) State the circumstance in which the Earth Wire would not be necessary in an electric appliance. Explain your answer.

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[3]

Q2

Fig. 12.1 shows an electric kettle connected to the 230 V mains supply.

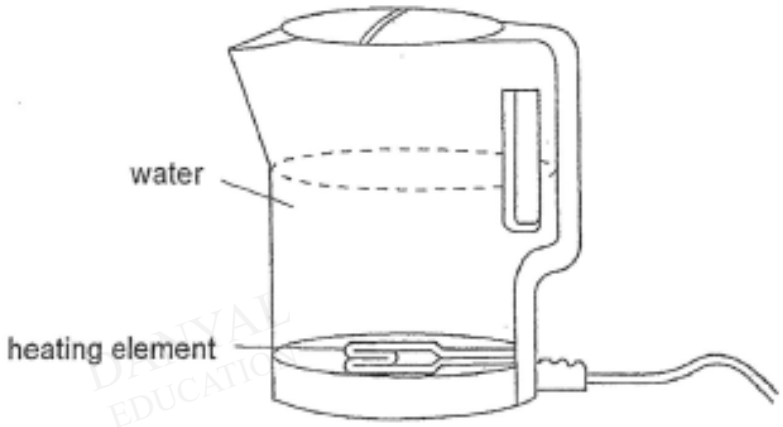

Fig 12.1

c) The power rating of the kettle is 1500 W.
What is the current drawn by the kettle during normal operating conditions?

current = ...A [2]

d) The kettle is designed with a fuse as a safety device.
Explain how a fuse works and suggest if a fuse rating of 6 A or 8 A is more suitable for the kettle.

.....

.....

.....

.....

..... [2]

e) The cost of electrical energy is 25 cents per kWh.
What is the cost of operating the kettle per day if it is being used for 20 minutes on average in one day?

cost = ...cents [2]

Q3

(a) Fig. 10.1 shows a water heater rated at 2.3 kW which operates from 240 V a.c. supply.

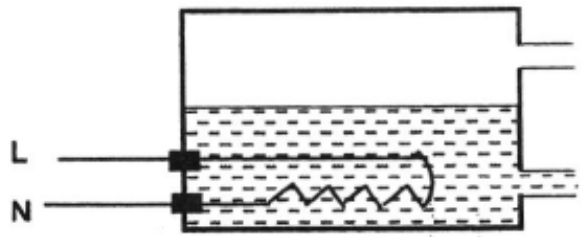

Fig. 10.1

(i) Calculate the current in the heating element. [2]

(ii) Suggest the rating of a fuse that can be used to protect the heater. [1]

.....

(iii) Explain how the earth wire protects the user from electrocution. [2]

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.....

.....

(iv) The heater takes 5 minutes to boil one container of water. Calculate the cost of electricity used for boiling 100 containers of water if the cost of electricity is $0.28 per kWh. [2]

Q4

Fig. 10.1 shows the electrical wiring in a 240 V, 2200 W washing machine. The Earth wire is connected to the metal casing of the washing machine. Both the Live and Neutral wires are connected to its heating element.

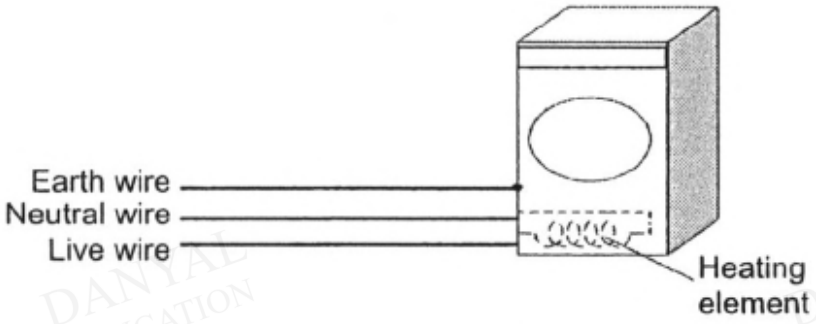


Fig. 10

(a) On which wire should the fuse be placed on? Explain your answer.

.....

.....[2]

(b) Describe how the Earth wire works in order to protect the user.

.....

.....

.....[2]

(c) State the current that flows in each of the wires when the washing machine is working normally. Show clear workings (if any).

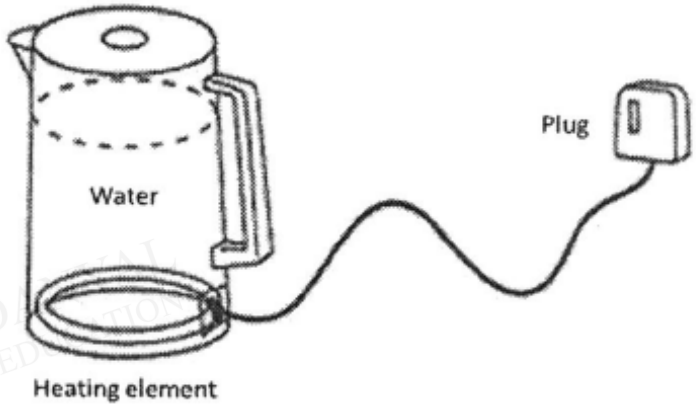
current in Earth wire = ...
current in Neutral wire = ...
current in Live wire = ...[3]

(d) The washing machine is used 4 times a week. The time taken by the washing machine to complete 1 cycle of washing, rinsing and spinning is 1 hour 15 minutes. Assuming that the washing machine completes 1 full cycle each time it is being used, calculate the cost of using the washing machine in a week if the cost of a unit of electricity is 25 cents.

cost = ...[3]

Q5

An electric kettle of 2000 W is connected to the electrical mains of 220 V.



(a) Calculate the resistance of the heating element. [2]

Resistance of heating element = _____ Ω

(b) The heating element inside the electric kettle is a long nichrome wire, which has a resistivity of 1.5×10^{-6} Ωm. If the heating element has to be exactly 0.2 m long, calculate the cross-sectional area of the heating element. [2]

Cross-sectional area = _____ m^2

(c) The cost of a unit (kWh) of electricity is 24 cents a month (30 days). If the electric kettle is turned on for 1 hour each day, calculate the cost of using the electric kettle every month. [2]

Cost = $ _____

Answers

Practical Electricity Test 3.0

Q1

a	P = IV or I = P / V I_{AC} = 2300 W / 240 V = 9.58 A I_{TV} = 280 W / 240 V = 1.17 A Total Current = 9.58 A + 1.17 A = 10.75 A = 10.8 A	[1] [1]
b	The fuse rating should be slightly higher than the total current in the circuit. Therefore, a suitable fuse rating would be 13A.	[1] [1]
c	When there is a short circuit, the main branch will carry a high current which will cause over-heating and possible electrical fire.	[1]
d	Cost = Rate x Energy Used = Rate x Power x Time Cost = ($0.12 / kWh) x [(2.3 kW x 8 h) + (0.28 kW x 4 h)] / day x 7 days Cost = ($0.12) (18.4 + 1.12) x 7 = $16.40	[1] [1]
e	Earth wire would not be necessary when the electric appliance has **double insulation**. With double insulation, even if the wiring loosens, the **live wire cannot touch the external casing**. This will **prevent the external casing from becoming live** and so **protects the user of the appliance from electrical shock**.	[1] [2]

Q2

c	P = VI 1500 = 230 I I = 6.5 A	 M1 A1
d	When the current drawn is larger than the fuse rating, the fuse will melt and break the circuit. 8 A fuse is more suitable.	A1 A1
e	Cost = kWh x rate = 1.5 kW x 20/60 x 25 cents = 12.5 cents	 M1 A1

Q3

(i) Calculate the current in the heating element. [2]

P = IV
I = 2300 / 240 [1]
= 9.58 A (3 sf) [1]

(ii) Suggest the rating of a fuse that can be used to protect the heater. [1]
Suggest to use a fuse of 10A. [1] Accept any fuse rating above 9.58 A

.....

(iii) Explain how the earth wire protects the user from electrocution. [2]
It provides a low resistance [1] conducting path for large current to flow to the earth
.....
should the metal case suddenly become 'live'[1]
.....

.....

(iv) The heater takes 5 minutes to boil one container of water. Calculate the cost of electricity used for boiling 100 containers of water if the cost of electricity is $0.28 per kWh. [2]

Total energy used = P x t = 2.3 x (5/60) x 100 = 19.17 kWh [1]

Total cost of electricity used = 19.17 x 0.28 = $5.37 [1]

Q4

(a) On which wire should the fuse be placed on? Explain your answer. [2]

Live wire. Machine will not be damaged by excessive current because the fuse melts and open circuit to stop it.

(b) Describe how the Earth wire works in order to protect the user. [2]

When a fault happens, the Earth wire provides a low resistance path for current to flow to ground. This prevents the metal casing from becoming live and causing the user an electric shock.

(c) State the current that flows in each of the wires when the washing machine is working normally. Show clear workings (if any).

$$I = \frac{P}{V}$$
$$= \frac{2200}{240}$$
$$= 9.17 \text{ A (3s.f.)}$$

current in Earth wire = **0 A**
current in Neutral wire = **9.17 A**
current in Live wire = **9.17 A** [3]

(d) The washing machine is used 4 times a week. The time taken by the washing machine to complete 1 cycle of washing, rinsing and spinning is 1 hour 15 minutes. Assuming that the washing machine completes 1 full cycle each time it is being used, calculate the cost of using the washing machine in a week if the cost of a unit of electricity is 25 cents. [3]

Total time of using washing machine = (1hr 15 min) x 4 = 5 hrs

Total Energy used = Pt
$= (2.2)(5)$
$= 11 \text{kWh}$

Cost = 11 × $0.25
= $2.75

Q5

(a) Calculate the resistance of the heating element. [2]

P = IV [1] & V = IR

$P = \frac{V^2}{R}$

R = 24.2 Ω [1]

(b) The heating element inside the electric kettle is a long nichrome wire, which has a resistivity of 1.5×10^{-6} Ωm. If the heating element has to be exactly 0.2 m long, calculate the cross-sectional area of the heating element. [2]

$R = \frac{\rho L}{A}$ [1]

$A = 1.24 \times 10^{-8}\ m^2$ [1]

(c) The cost of a unit (kWh) of electricity is 24 cents a month (30 days). If the electric kettle is turned on for 1 hour each day, calculate the cost of using the electric kettle every month. [2]

Energy = Power x time [1]
= 2 kW x 1 h x 30 days
= 60 kWh x 24 cents
=$14.40 [1]