Hong Kong Diploma of Secondary Education Examination

Physics – Compulsory part (必修部分)

Section A – Heat and Gases (熱和氣體)
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普遍氣體定律)
5. Kinetic Theory (分子運動論)

Section B – Force and Motion (力和運動)
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

Section C – Wave Motion (波動)
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

Section D – Electricity and Magnetism (電和磁)
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

Section E – Radioactivity and Nuclear Energy (放射現象和核能)
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

Physics – Elective part (選修部分)

Elective 1 – Astronomy and Space Science (天文學和航天科學)
1. The universe as seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恆星和宇宙)

Elective 2 – Atomic World (原子世界)
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

Elective 3 – Energy and Use of Energy (能量和能源的使用)
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

Elective 4 – Medical Physics (醫學物理學)
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)

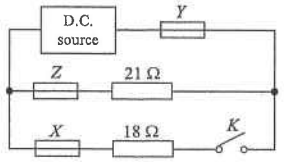
DSE Physics - Section D : M.C. PD - EM3 - M / 01
EM3 : Domestic Electricity

The following list of formulae may be found useful :

Resistance and resistivity	$R = \frac{\rho l}{A}$
Resistors in series	$R = R_1 + R_2$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
Power in a circuit	$P = IV = I^2R$

Part A : HKCE examination questions

1. < HKCE 1980 Paper II - 33 >



In the circuit shown, Y is a 5 A fuse, Z and X are 3 A fuses. When the switch K is open the current passing through the 21 Ω resistor is 2.4 A. When K is closed, which of the fuses will be blown ?

A. X only
B. Y only
C. Z only
D. X and Z only

2. < HKCE 1982 Paper II - 26 >

The table below shows the voltage and power rating for various electrical appliances. Which of the electric appliances has the smallest working resistance ?

	Appliance	Voltage	Power / W
A.	Air-conditioner	200	2000
B.	Television	200	250
C.	Heater	100	2000
D.	Hair-dryer	100	20

3. < HKCE 1982 Paper II - 28 >

A set of Christmas tree lights consists of 20 bulbs in series. Each bulb has a rating of "10 V 5 W". One of the bulbs burns out and Jimmy goes to buy a replacement. When he gets back, he finds that although the new bulb is marked 5 W, it looks dimmer than the others when the lights are turned on. The most probable reason for this is that the new bulb

A. has a smaller current flowing through it.
B. has a filament with a higher resistance.
C. has been shorted accidentally.
D. is designed to work at a lower voltage.

4. **< HKCE 1982 Paper II - 29 >**

Fifteen bulbs, each labelled '200 V 60 W', are connected in parallel to a 200 V supply. Which of the following fuses should be used in the circuit ?

A. 2 A
B. 3 A
C. 4 A
D. 5 A

5. **< HKCE 1983 Paper II - 35 >**

Eight 100 W lamps and one 1000 W heater are all connected in parallel to a mains supply of 200 V. Which of the following should be used ?

A. 5 A fuse
B. 10 A fuse
C. 30 A fuse
D. 50 A fuse

6. **< HKCE 1984 Paper II - 30 >**

Which of the following has the greatest current when it is operated at 200 V ?

A. a lamp with a resistance of 400 Ω
B. a rice-cooker with rating of 400 W at 200 V
C. an electric iron with rating of 400 W at 220 V
D. a hair-dryer with rating of 600 W at 200 V

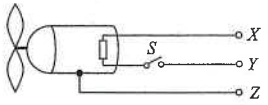
7. **< HKCE 1984 Paper II - 27 >**

Two heaters of rating '1 kW, 200 V' and '2 kW, 200 V' respectively are connected in series to a 200 V supply. What is the total power consumed by the heaters ?

A. 3 kW
B. 1.5 kW
C. 1 kW
D. 0.67 kW

8. **< HKCE 1984 Paper II - 35 >**

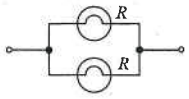
In the figure shown, *S* is a switch to turn on and off the electric fan. *X*, *Y* and *Z* are wires to be connected to the three terminals of a plug. How should *X*, *Y* and *Z* be connected to the three pins (E, L and N) of a given plug ?

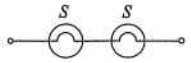


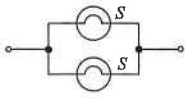
	Earth	Live	Neutral
A.	*X*	*Y*	*Z*
B.	*Y*	*X*	*Z*
C.	*Z*	*Y*	*X*
D.	*X*	*Z*	*Y*

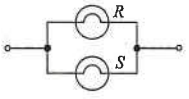
9. **< HKCE 1985 Paper II - 37 >**

Electric bulbs *R* are of rating "40 W, 200 V" and electric bulbs *S* are of rating "60 W, 200 V". Which of the following combinations would produce the maximum brightness if connected to the same voltage ?

A.


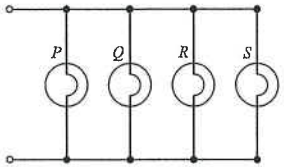
B.


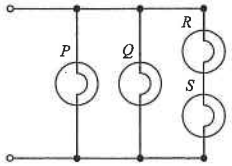
C.


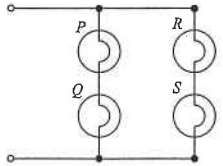
D.


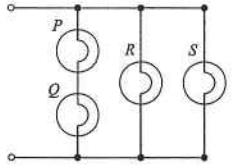
10. **< HKCE 1986 Paper II - 36 >**

P and *Q* are bulbs of rating "40 W, 200 V" while *R* and *S* are of rating "60 W, 200 V'. Which of the following circuits gives the maximum brightness ?
(Assume all circuits are connected to the same voltage.)

A.


B.


C.


D.


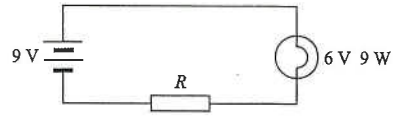
11. **< HKCE 1986 Paper II - 32 >**

An electric heater of rating "2000 W, 200 V" and an electric cooker of rating "500 W, 200 V" are connected in parallel to a 200 V a.c. source. The total power of the two appliances is

A. 500 W.
B. 1500 W.
C. 2000 W.
D. 2500 W.

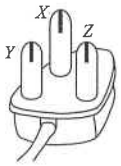
12. **< HKCE 1987 Paper II - 29 >**

The circuit shows a lamp of rating '6 V, 9 W' connected in series with a resistor *R* and a 9 V battery. What should be the resistance of *R* if the lamp is to work as rated ?



A. 2 Ω
B. 3 Ω
C. 4 Ω
D. 5 Ω

13. **< HKCE 1987 Paper II - 27 >**



In the three-pin plug as shown, *X*, *Y* and *Z* are respectively connected to the

	X	*Y*	*Z*
A.	earth	neutral	live
B.	earth	live	neutral
C.	neutral	earth	live
D.	neutral	live	earth

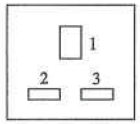
14. **< HKCE 1988 Paper II - 33 >**

A 3-pin plug is connected to a boiler of rating "2000 W, 200 V". Which of the following statements is/are true ?

(1) A 5 A fuse should be used in the circuit.
(2) The fuse should be placed on the brown wire of the cable.
(3) The yellow and green wire of the cable should be connected to the earth pin.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

15. **< HKCE 1989 Paper II - 39 >**



A standard three-pin socket on the wall is shown in the figure. Which of the following is correct ?

	Pin (1)	**Pin (2)**	**Pin (3)**
A.	neutral	live	earth
B.	neutral	earth	live
C.	earth	live	neutral
D.	earth	neutral	live

16. **< HKCE 1989 Paper II - 37 >**

Operating voltage	220 V / 50 Hz
Power	1500 W
Fuse Rating	30 A

The diagram shows the label attached to an electric appliance. How much electrical energy is supplied to the appliance in 2 hours ?

A. 2.0 kWh
B. 2.5 kWh
C. 3.0 kWh
D. 6.0 kWh

17. **< HKCE 1991 Paper II - 28 >**

For safety, the correct way of connecting the fuse and switch to electrical appliances should be

A. fuse in live wire, switch in neutral wire.
B. fuse in earth wire, switch in live wire.
C. both in neutral wire.
D. both in live wire.

18. **< HKCE 1991 Paper II - 36 >**

Two light bulbs *A* and *B* of ratings '10 W, 6 V' and '5 W, 6 V' respectively are connected in series to a 6 V battery. Which of the following is/are correct ?

(1) The resistance of *A* is smaller than that of *B*.
(2) The current through *A* is the same as that through *B*.
(3) *A* is brighter than *B*.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

19. **< HKCE 1993 Paper II - 33 >**

Which of the following is NOT a correct unit for the corresponding physical quantity ?

	Physical quantity	**Unit**
A.	charge	coulomb
B.	current	ampere
C.	resistance	ohm
D.	voltage	joule

20. **< HKCE 1994 Paper II - 30 >**

The diagram shows the label attached to a rice cooker. Which of the following statements is/are true when the cooker is working at its rated values ?

Operating voltage	220 V / 50 Hz
Power	500 W

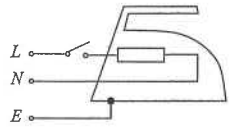
(1) The resistance of the cooker is 96.8 Ω.
(2) The cooker draws a current of 4.4 A from the mains supply.
(3) The cooker consumes 1 kWh of electrical energy in 2 hours.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

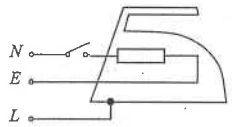
21. **< HKCE 1994 Paper II - 29 >**

Which of the following diagrams correctly shows the connection of the wires of an iron to the pins of a plug ?
(*L* : Live, *N* : Neutral, *E* : Earth)

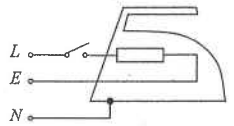
A.



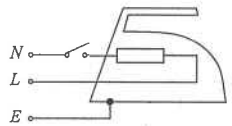
B.



C.



D.

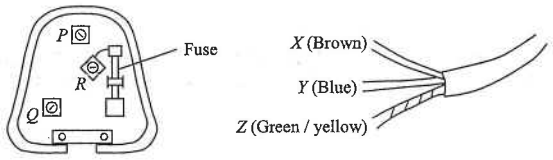


22. **< HKCE 1995 Paper II - 28 >**

Which of the following values is equivalent to one kilowatt hour ?

A. 1000 W
B. 1000 J
C. 3.6×10^6 W
D. 3.6×10^6 J

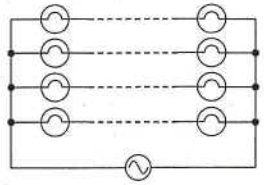
23. **< HKCE 1995 Paper II - 35 >**



The diagram above shows a three-pin plug and the wires connected to it. To which of the pins should each of the wires *X*, *Y* and *Z* be connected ?

	P	*Q*	*R*
A.	*Z*	*Y*	*X*
B.	*Y*	*X*	*Z*
C.	*Y*	*Z*	*X*
D.	*Z*	*X*	*Y*

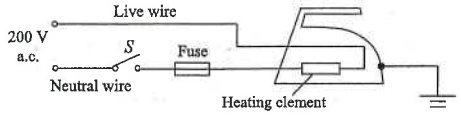
24. **< HKCE 1995 Paper II - 30 >**



A Christmas tree is illuminated with four strings of light bulbs. Each string has ten identical light bulbs connected in series as shown in the figure. If one light bulb suddenly burns out, which of the following will happen ?

A. Only that light bulb will go out.
B. One light bulb in each string will go out.
C. One string of light bulbs will go out.
D. All of the light bulbs will go out.

25. **< HKCE 1996 Paper II - 34 >**



The switch *S* and the fuse of an iron are incorrectly fitted in the neutral wire as shown above. Which of the following statements is correct ?

A. The iron will not operate even when *S* is on.
B. The iron will still operate even when *S* is off.
C. The iron will still operate, but if there is a high current the fuse will not blow.
D. The iron will still operate, but the heating element will remain at a high voltage even when *S* is off.

26. **< HKCE 1997 Paper II - 28 >**

The kilowatt-hour is a unit of

A. charge.
B. current.
C. energy.
D. power.

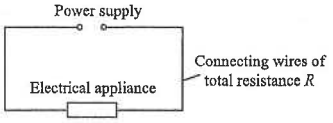
27. **< HKCE 1997 Paper II - 30 >**

Which of the following statements about the earth wire in an electric iron is/are correct ?

(1) The earth wire should be connected to the metal body of the iron.
(2) If the iron is working properly, no current pass through the earth wire.
(3) In case the neutral wire is broken, the earth wire provides a spare wire for the return path to the mains socket.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

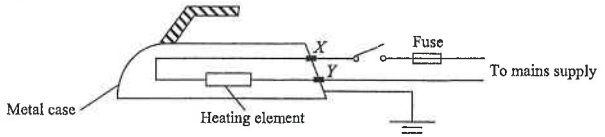
28. **< HKCE 1998 Paper II - 33 >**



An electric appliance is connected to a power supply of voltage *V* by long connecting wires of total resistance *R* as shown in the circuit. It is found that the current passing through the appliance is only $\frac{1}{2} I_o$, where I_o is the current required for the appliance to work at its rated value. Which of the following changes could increase the current through the appliance to I_o ?

	Voltage of power supply	**Total resistance of connecting wires**
A.	increases to $2V$	remains unchanged
B.	increases to $2V$	reduces to $R/2$
C.	remains unchanged	increases to $2R$
D.	remains unchanged	reduces to $R/2$

29. **< HKCE 2000 Paper II - 35 >**



The above diagram shows the main parts of an electric iron. In which of the following situations will the fuse blow when the switch is closed ?

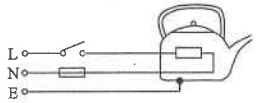
(1) The insulation at contact point *X* is worn out so that the wire touches the metal case.
(2) The insulation at contact point *Y* is worn out so that the wire touches the metal case.
(3) The heating element is broken.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

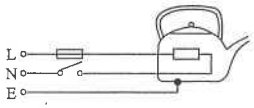
30. **< HKCE 2001 Paper II - 31 >**

Which of the following diagrams shows the correct connection of the fuse and switch of an electric kettle to the mains supply ? (L : live, N : neutral, E : earth)

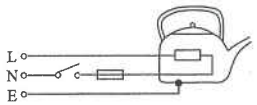
A.



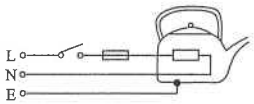
B.



C.



D.



31. **< HKCE 2001 Paper II - 32 >**

Two electric heaters X and Y are of ratings '110 V, 40 W' and '110 V, 80 W' respectively. Which of the below deductions about the two heaters is/are correct ?

(1) The operating resistance of X is twice that of Y.

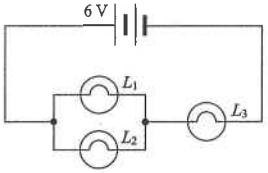
(2) X will consume a power of 80 W when it is connected to a 220 V mains supply.

(3) Both heaters work at their rated values when they are connected in series to a 220 V mains supply.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

32. **< HKCE 2002 Paper II - 34 >**

Three identical lamps L_1, L_2 and L_3 of ratings '6 V, 12 W' are connected to a 6 V battery as shown in the figure. Which of the following statements is correct ?



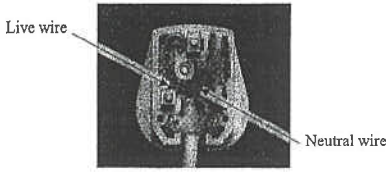
A. The voltage across L_2 is 3 V.

B. The current passing through L_1 is 2 A.

C. The total power drawn from the battery is 12 W.

D. The total power dissipated in L_1 and L_2 is smaller than that in L_3.

33. **< HKCE 2002 Paper II - 36 >**



If the live and neutral wires of an electric kettle are mistakenly interchanged inside the plug as shown above, which of the following will happen ?

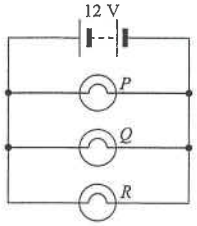
A. The kettle will not operate.

B. The fuse of the kettle will blow.

C. The metal case of the kettle will still stand at a high voltage even when the switch of the kettle is off.

D. The heating element of the kettle will still stand at a high voltage even when the switch of the kettle is off.

34. **< HKCE 2003 Paper II - 34 >**

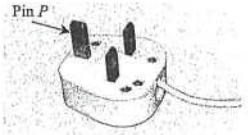


Three light bulbs P, Q and R of ratings '24 V, 80 W', '12 V, 80 W' and '12 V, 40 W' respectively are connected in parallel to a 12 V battery. Which of the bulbs will be the brightest, and which will be the dimmest ?

	The brightest	The dimmest
A.	P	Q
B.	P	R
C.	Q	P
D.	Q	R

35. **< HKCE 2003 Paper II - 35 >**

The photograph shows a three-pin plug of an appliance. Which of the following is a function of pin P ?



A. It prevents the appliance from being short-circuit.

B. It protects the user from getting an electric shock.

C. It provides a return path for the current.

D. It can break the circuit when the current flowing through the appliance is too large.

36. **< HKCE 2003 Paper II - 36 >**

ENERGY LABEL
能源 標籤

Brand 牌子	XXX
Model 型號	XXX
Annual Energy Consumption kWh/year 每年耗電量 每年千瓦小時 **Actual consumption will depend on where the appliance is located and how it is used. Assume 260 washes per year.** 其耗電量視乎電器的安裝地點及使用方式。現假設每年洗衣 260 次。	250
Energy Efficiency Grade 能源效益級別	X
Washing Machine Category 洗衣機類別	XXX
EEL Registration Number 能源標籤登記號碼	XXX

The figure shows the energy label of a washing machine. If the average working time per wash is 1.8 hours, estimate the average electric power consumed by the machine.

A. 450 W
B. 534 W
C. 962 W
D. 1731 W

37. **< HKCE 2004 Paper II - 33 >**

One day, Donald used the following electrical appliances at home :

Appliance	Rating	Duration	Cost of electricity
electric heater	220 V, 2500 W	30 minutes	C_1
television	220 V, 270 W	5 hours	C_2
lamp	220 V, 150 W	8 hours	C_3

Which of the following relationships is correct ?

A. $C_1 > C_2 > C_3$
B. $C_2 > C_1 > C_3$
C. $C_2 > C_3 > C_1$
D. $C_3 > C_2 > C_1$

38. **< HKCE 2005 Paper II - 20 >**

The following table shows three electrical appliances which Clara used in a certain month :

Appliance	Rating	Duration
air-conditioner	220 V, 1200 W	250 hours
television	220 V, 250 W	80 hours
computer	220 V, 150 W	60 hours

Calculate the cost of electricity used. Note : 1 kW h of electricity costs $ 0.86.

A. $ 62.25
B. $ 73.79
C. $ 282.94
D. $ 536.64

39. **< HKCE 2005 Paper II - 21 >**

If a 15 A fuse is installed in the plug of an electric kettle of rating value '220 V, 900 W', which of the following descriptions is correct ?

A. The kettle will not operate.
B. The kettle will be short-circuited.
C. The output power of the kettle will be increased.
D. The chance of the kettle being damaged by an excessive current will be increased.

40. **< HKCE 2006 Paper II - 24 >**

An electrical appliance is protected by a fuse in a domestic circuit. When the appliance is switched on, the fuse blows immediately. Which of the following statements is/are possible reason(s) for this phenomenon ?

(1) The resistance of the appliance is too large.
(2) The appliance is short-circuited.
(3) The rated value of the fuse is too small.

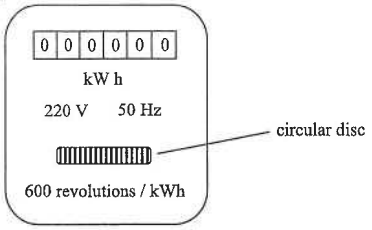
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

41. **< HKCE 2006 Paper II - 40 >**

Two light bulbs are marked '220 V, 50 W' and '220 V, 100 W' respectively. If they are connected in series to a 220 V mains supply, what is the current drawn from the mains supply ?

A. 0.15 A
B. 0.23 A
C. 0.46 A
D. 0.68 A

42. **< HKCE 2006 Paper II - 21 >**

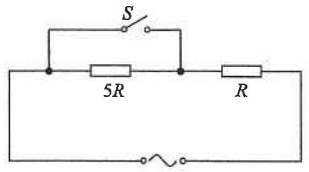


The figure shows the label of a kilowatt-hour meter connected to a mains supply. When an appliance is switched on for 2 minutes, the circular disc rotates through 24 complete revolutions. What is the electric power consumed by the appliance ?

A. 900 W
B. 1200 W
C. 1800 W
D. 2400 W

43. **< HKCE 2006 Paper II - 41 >**

In the circuit shown, the resistors represent the heating elements in a rice cooker. The resistances of the elements are $5R$ and R respectively. The rice-cooker can be operated in two modes, namely, cooking and keeping warm. The power consumed by the cooker in the cooking mode is 600 W when S is closed. What is the power consumed by the rice-cooker in the mode of keeping warm when S is open ?



A. 100 W
B. 120 W
C. 150 W
D. 180 W

44. **< HKCE 2006 Paper II - 39 >**

An electric appliance draws a current 2 A when it is operating at 220 V. Which of the following is the best description of the current and the voltage of each wire of the electric appliance when it is connected to a 220 V mains supply ?

	Live wire		Neutral wire		Earth wire	
	Current	Voltage	Current	Voltage	Current	Voltage
A.	2 A	220 V	1 A	220 V	1 A	0
B.	2 A	220 V	2 A	220 V	0	0
C.	2 A	220 V	2 A	0	0	0
D.	2 A	220 V	0	0	0	0

45. **< HKCE 2007 Paper II - 18 >**

A household circuit breaker is marked '220 V, 15 A'. Now an electric iron rated '220 V, 1100 W' and a cooker rated '220 V, 550 W' are connected in parallel to the mains socket. How many light bulbs rated '220 V, 100W' at most can still be connected in parallel to the mains without triggering the circuit breaker ?

A. 12
B. 16
C. 17
D. 20

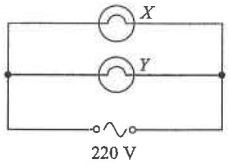
46. **< HKCE 2008 Paper II - 22 >**

A lighting system consists of 3 bulbs, each rated '220 V 30 W'. These three bulbs should be connected in parallel to the 220 V mains supply. However, the bulbs are wrongly connected in series to the mains supply. What is the power dissipation of the wrongly connected system ?

A. 3.33 W
B. 10 W
C. 30 W
D. 90 W

47. **< HKCE 2009 Paper II - 18 >**

Two identical bulbs, *X* and *Y*, are connected in parallel to the mains. The current passing through *X* is 0.4 A. What is the energy consumed by the two bulbs in 5 hours ?



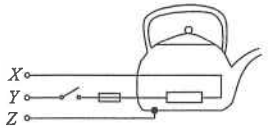
A. 0.44 kWh
B. 0.88 kWh
C. 440 kWh
D. 880 kWh

48. **< HKCE 2009 Paper II - 20 >**

The power ratings and resistances of two light bulbs are "24 W, 6 Ω" and "9 W, 4 Ω" respectively. If these two light bulbs are connected in parallel to a power supply, what is the maximum current drawn from the power supply so that both light bulbs are working within the rated power ?

A. 2.0 A
B. 2.5 A
C. 3.5 A
D. 4.8 A

49. **< HKCE 2009 Paper II - 23 >**

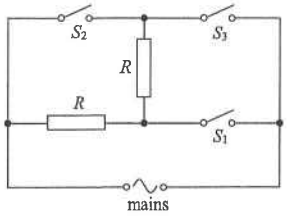


Which of the following is the correct connection of *X*, *Y* and *Z* to the mains ?

	X	*Y*	*Z*
A.	live	earth	neutral
B.	live	neutral	earth
C.	neutral	earth	live
D.	neutral	live	earth

50. **< HKCE 2009 Paper II - 41 >**

A mains heater has two identical heating elements of same resistance *R*.

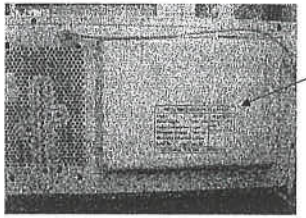


When S_1 and S_2 are closed and S_3 is open, the power of the heater is *P*. What is the power of the heater when S_1 and S_2 are open and S_3 is closed ?

A. 0.25 *P*
B. 0.5 *P*
C. 2 *P*
D. 4 *P*

51. **< HKCE 2010 Paper II - 16 >**

The photo below shows the back of a microwave oven.



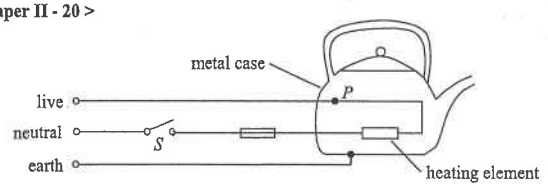
Power supply :	220 V ~ 50 Hz
Power consumption :	1150 W
Microwave output :	750 W
Microwave frequency :	2450 MHz

Which of the following statements is/are correct ?

(1) The current flowing through the microwave oven is about 3.4 A.
(2) Around 65% of electrical energy is converted into energy carried by microwave.
(3) The wavelength of the microwave emitted is about 0.12 m.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

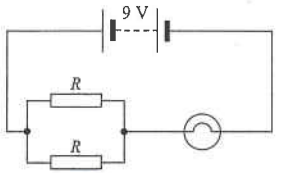
52. **< HKCE 2010 Paper II - 20 >**



In the figure above, the kettle is wired incorrectly. Which of the following statements is correct when point *P* is accidentally connected to the metal case ?

A. The kettle will still operate at its rated value when *S* is closed.
B. The fuse will blow when *S* is closed.
C. The heating element will burn out when *S* is closed.
D. A current will flow through the live wire even when *S* is open.

53. **< HKCE 2010 Paper II - 19 >**



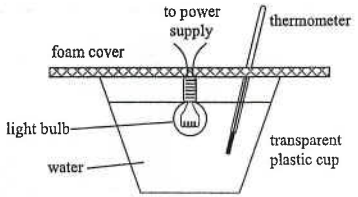
In the circuit above, the rating of the bulb is "6 V, 12 W". Find the resistance of *R* so that the bulb will work at its rated value.

A. 2 Ω
B. 3 Ω
C. 4 Ω
D. 6 Ω

54. **< HKCE 2011 Paper II - 11 >**

As shown in the figure, a 2 W light bulb is immersed into 50 g of water. The bulb is operating at its rated value. After 10 minutes, the temperature of the water increases by 4.5°C. Estimate the amount of light emitted during the 10 minutes.

Given : specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$



A. 255 J
B. 690 J
C. 945 J
D. 1200 J

Part B : HKAL examination questions

55. **< HKAL 1980 Paper I - 22 >**

Torch bulbs marked "3 V, 1.5 W", are to be used in a circuit by using 6 V battery. What should be the number of bulbs connected in the circuit if the steady current drawn from the battery is to be 2 A and each bulb gives normal brightness ?

A. 2
B. 3
C. 4
D. 8

56. **< HKAL 1983 Paper I - 43 >**

A set of Christmas tree lights consists of 20 light bulbs in series connected to a supply of 200 V. Each light bulb has a rating of "10 V, 5 W". When one bulb burns out, Jenny goes to buy a replacement. When she gets back, she finds that although the new bulb is marked 5 W, the light it gives is dimmer than the other bulbs. Which of the following is a possible reason ?

(1) The supply voltage has dropped below 200 V.
(2) The current through the circuit is less than 0.5 A.
(3) The rated voltage of the new bulb is less than 10 V.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

Part C : Supplemental exercise

57. In a household circuit, as more lamps are switched on, which of the following statements are correct ?

(1) The equivalent resistance of the whole circuit increases.
(2) The total power consumption increases.
(3) The total current drawn increases.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

58. Which of the following statements concerning the fuse in an electrical appliance are correct ?

(1) A fuse is made of a metal with low melting point.
(2) If the fuse in an electrical appliance is blown, it should not be replaced by a piece of copper wire.
(3) If copper is used to replace the blown fuse, it will cause short circuit of the appliance as copper has low resistance.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

59. Small light bulbs of rating "12 V, 6 W" are to be used in a circuit. The voltage of the power supply is 24 V and the current drawn from the supply is 2 A. What is the number of light bulbs connecting in the circuit so that each light bulb is under normal rating ?

A. 2
B. 4
C. 8
D. 16

60. Which of the following statements concerning two light bulbs with rated values, '200 V, 100 W' and '200 V, 40 W', are correct ?

(1) The energy dissipated by the '200 V, 100 W' light bulb is greater than that of the '200 V, 40 W' light bulb when they work at their rated values.
(2) The current flowing through the '200 V, 100 W' light bulb is greater than that of the '200 V, 40 W' light bulb when they work at their rated values.
(3) The resistance of the '200 V, 100 W' light bulb is greater than that of the '200 V, 40 W' light bulb when they work at their rated values.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

61. Which of the following concerning the household circuit is/are correct ?

(1) Fuse should be installed in the live wire of an electrical appliance.
(2) Switch should be installed in the neutral wire of an electrical appliance.
(3) Current always flows from the live wire through the appliance to the neutral wire.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

62. Which of the following statements concerning two light bulbs with rated values, '200 V, 100 W' and '200 V, 40 W', is/are correct ?

(1) The resistance of the '200 V, 100 W' light bulb is greater than that of the '200 V, 40 W' light bulb.
(2) The current flowing through the '200 V, 100 W' light bulb is greater than that of the '200 V, 40 W' light bulb when they are connected in series.
(3) The power dissipated by the '200 V, 100 W' light bulb is smaller than that of the '200 V, 40 W' light bulb when they are connected in series.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

Part D : HKDSE examination questions

63. < HKDSE Sample Paper IA - 26 >

If a 15 A fuse is installed in the plug of an electric kettle of rating value '220 V, 900 W', state what happens when the kettle is plugged in and switched on.

A. The kettle will not operate.
B. The kettle will be short-circuited.
C. The output power of the kettle will be increased.
D. The chance of the kettle being damaged by an excessive current will be increased.

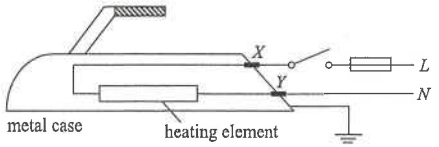
64. < HKDSE Sample Paper IA - 25 >

The table shows three electrical appliances which Clara used in a certain month :

Appliance	Rating	Duration
air-conditioner	220 V, 1200 W	250 hours
television	220 V, 250 W	80 hours
computer	220 V, 150 W	60 hours

Calculate the cost of electricity used. Note : 1 kW h of electricity costs $ 0.86.
A. $ 62.25
B. $ 73.79
C. $ 282.94
D. $ 536.64

65. < HKDSE Practice Paper IA - 30 >



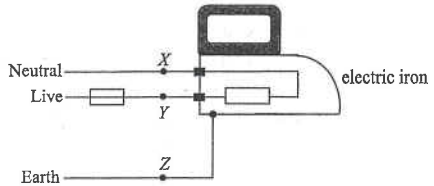
The figure above shows the main parts of an electric iron. In which of the following situations will the fuse blow when the switch is closed ?
A. The heating element is broken and becomes an open circuit.
B. The earth wire is worn out and becomes disconnected.
C. The insulation at contact point *X* is worn out so that the wire touches the metal case.
D. The insulation at contact point *Y* is worn out so that the wire touches the metal case.

66. < HKDSE 2012 Paper IA - 33 >

The figure shows a simple domestic circuit for an electric iron. The fuse will blow when which of the following points are short-circuited ?

(1) *X* and *Y*
(2) *Y* and *Z*
(3) *X* and *Z*

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only



67. < HKDSE 2013 Paper IA - 33 >

Which of the following domestic electrical appliances consumes a power close to 1 kW in normal working conditions ?
A. an electric fan
B. a microwave oven
C. a fluorescent lamp
D. a TV set

68. < HKDSE 2015 Paper IA - 28 >

Which statement is **NOT** a reason why mains socket at home are connected in parallel instead of a series circuit ?
A. Electrical appliances connected to different sockets can be switched on or off independently.
B. Voltage supplied to each socket is fixed and all electrical appliances can operate at their rated voltage.
C. The current supplied can be reduced and thinner cables can then be used.
D. When an electrical appliance breaks down and becomes an open circuit, other appliances can still work normally.

69. < HKDSE 2015 Paper IA - 29 >

An electric iron of 1800 W sold in Hong Kong (220 V 50 Hz) is connected to a 110 V 60 Hz mains socket in another country. How does its performance compare on the same ironing setting ?
A. The electric iron does not work because the a.c. supply is 60 Hz instead of 50 Hz.
B. The electric iron is as hot as it is used in Hong Kong.
C. The electric iron is hotter than when it is used in Hong Kong.
D. The electric iron is colder than when it is used in Hong Kong.

70. < HKDSE 2016 Paper IA - 28 >

A television set in stand-by mode consumes 1.5 W. If it is in this mode for 16 hours a day, estimate the carbon dioxide (CO_2) emission due to the electricity consumed in stand-by mode in a 30-day month.

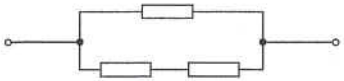
Given : 1 kW h of electricity consumed corresponds to 0.8 kg CO_2 emission from the power station.

A. 0.576 kg
B. 0.720 kg
C. 576 kg
D. 720 kg

71. < HKDSE 2017 Paper IA - 25 >

Which of the following statements about the use of a fuse is correct ?
A. A fuse should be installed in the neutral wire.
B. A fuse is not required in an electrical appliance with double insulation.
C. A 5A fuse is suitable for a heater of rating '220 V, 1500 W'.
D. The melting point of a fuse should be lower than that of copper.

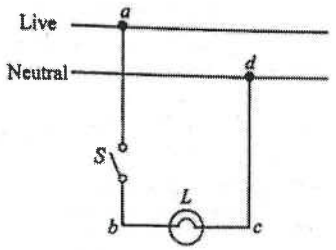
72. < HKDSE 2018 Paper IA - 24 >



Three identical resistors are arranged as shown. The rated power of each resistor is 12 W. If no resistor exceeds its rated power, what is the maximum power dissipation in such an arrangement ?
A. 16 W
B. 18 W
C. 20 W
D. 24 W

73. <HKDSE 2020 Paper IA-24>

The figure shows part of a domestic lighting circuit in which the bulb L does not light up when switch S is closed.



The circuit is then checked with switch S closed. Using a voltage tester to touch points b and c in turns, the tester indicates that both points are at high voltage. When touching points a and d in turns, the tester indicates only point a is at high voltage. Which of the following can be a reason for the fault ?

A. The switch S has been damaged.
B. The filament of bulb L has been burnt out and becomes an open circuit.
C. There is a short circuit between a and d.
D. There is an open circuit between c and d.

74. <HKDSE 2020 Paper IA-25>

The battery shown has a capacity of 1100 mA h. How much energy is delivered when the battery operates normally at a current of 250 mA for one hour ? Assume that the battery's operating voltage remains at 3.7 V during that period.

A. $(3.7 \times \frac{250}{1000} \times 3600)$ J
B. $(3.7 \times \frac{1100}{1000} \times 3600)$ J
C. $(3.7 \times \frac{250}{1000} \times 1)$ J
D. $(3.7 \times \frac{1100}{1000} \times 1)$ J

M.C. Answers

1.	B	11.	D	21.	A	31.	A	41.	A
2.	C	12.	A	22.	D	32.	D	42.	B
3.	D	13.	B	23.	A	33.	D	43.	A
4.	D	14.	D	24.	C	34.	C	44.	C
5.	B	15.	D	25.	D	35.	B	45.	B
6.	D	16.	C	26.	C	36.	B	46.	B
7.	D	17.	D	27.	C	37.	B	47.	B
8.	C	18.	C	28.	A	38.	C	48.	B
9.	C	19.	D	29.	A	39.	D	49.	D
10.	A	20.	C	30.	D	40.	D	50.	A

51.	D	61.	A	71.	D				
52.	D	62.	B	72.	B				
53.	B	63.	D	73.	D				
54.	A	64.	C	74.	A				
55.	D	65.	C						
56.	B	66.	C						
57.	C	67.	B						
58.	A	68.	C						
59.	C	69.	D						
60.	A	70.	A						

M.C. Solution

1. B

Voltage across 18 Ω = voltage across 21 Ω = (2.4)(21) = 50.4 V

$I_X = \frac{50.4}{18} = 2.8\,\text{A} < 3\,\text{A}$ ∴ fuse X will not be blown

$I_Y = I_X + I_Z = 2.8 + 2.4 = 5.2\,\text{A} > 5\,\text{A}$ ∴ fuse Y will be blown

2. C

A. $R = \frac{V_r^2}{P_r} = \frac{(200)^2}{(2000)} = 20\,\Omega$

B. $R = \frac{(200)^2}{(250)} = 160\,\Omega$

C. $R = \frac{(100)^2}{(2000)} = 5\,\Omega$

D. $R = \frac{(100)^2}{(20)} = 50\,\Omega$

∴ Heater has the smallest resistance.

3. D

× A. If current is smaller current, then all bulbs would become dimmer

× B. If the resistance is higher, then it should give greater power as $P = I^2 R$, and thus become brighter

× C. If the bulb is shorted accidentally, then it does not work and would not look dimmer

✓ D. As $R = \frac{V_r^2}{P_r}$, for the same rated power 5 W but lower rated voltage, the new bulb has smaller resistance by $P = I^2 R$, the new bulb has smaller power and thus looks dimmer

4. D

$I = \frac{P_r}{V_r} \times 15 = \frac{60}{200} \times 15 = 4.5\,\text{A}$

Value of fuse should be equal to or greater than I

∴ 5 A is the appropriate one

5. B

$I = \frac{P_1}{V} \times 8 + \frac{P_2}{V} = \frac{100}{200} \times 8 + \frac{1000}{200} = 9\,\text{A}$

Value of fuse should be equal to or greater than I ⇒ 10 A is the appropriate one

6. D

By $R = \frac{V_r^2}{P_r}$, for hair dryer : $R = \frac{(200)^2}{(600)} = 66.7\,\Omega$ which is the smallest resistance.

∴ It gives the greatest current for a given voltage.

7. D

$R_{1\text{kW}} = \frac{(200)^2}{1000} = 40\,\Omega$ and $R_{2\text{kW}} = \frac{(200)^2}{2000} = 20\,\Omega$

∴ Equivalent resistance = 40 + 20 = 60 Ω

∴ $P = \frac{V^2}{R} = \frac{(200)^2}{(60)} = 0.67\,\text{kW}$

8. C

Earth : Z (connected to the metal case of the electric fan)

Live : Y (this wire has a switch)

Neutral : X (giving a returning path)

9. C

$R_R = \frac{(200)^2}{40} = 1000\,\Omega$, $R_S = \frac{(200)^2}{60} = 667\,\Omega$

(1) smaller resistances in parallel gives smaller equivalent resistance (by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$),

(2) smaller equivalent resistance ⇒ larger current ⇒ maximum brightness (for same voltage)

∴ C gives the maximum brightness.

10. A

All resistors in parallel must give the smallest equivalent resistance, thus it gives the maximum brightness

11. D

For the two appliances working in rated values, P = 2000 + 500 = 2500 W.

12. A

As $V_R = 3$ V

$\therefore I = \frac{P_r}{V_r} = \frac{9}{6} = 1.5$ A

$\therefore R = \frac{V_R}{I} = \frac{3}{1.5} = 2\ \Omega$

13. B

The longest pin X is the Earth pin.

Pin Y is the Live pin and pin X is the Neutral pin.

14. D

× (1) $I = \frac{P_r}{V_r} = \frac{2000}{200} = 10$ A > 5 A $\therefore$ 5 A fuse should not be used, otherwise, it will be blown.

✓ (2) As the brown wire is the live wire, the fuse should be placed on it to allow the fuse cutting off the circuit when the current is too large.

✓ (3) Yellow and green wire is the earth wire.

15. D

Pin 1 is the Earth socket.

Pin 2 is the Neutral socket.

Pin 3 is the Live socket.

16. C

$E = Pt$

$= (1.5) \times (2) = 3$ kWh

17. D

Fuse is used to limit the current of circuit. Switch is used to turn off the appliance from the circuit.

Both of them should be connected to the live wire,

so that the appliance is cut off from high voltage when the circuit is disconnected.

18. C

✓ (1) By $R \propto \frac{V_r^2}{P_r} \propto \frac{1}{P_r}$ $\therefore A$: larger rated power $P_r \Rightarrow$ smaller resistance R

✓ (2) In series $\Rightarrow$ same current passing through

× (3) By $P = I^2R$, A : smaller resistance and same current $\Rightarrow$ smaller power output $\Rightarrow$ dimmer

19. D

Voltage : unit V (volt)

20. C

✓ (1) $R = \frac{V_r^2}{P_r} = \frac{(220)^2}{500} = 96.8\ \Omega$

× (2) $I_r = \frac{P_r}{V_r} = \frac{500}{220} = 2.27$ A

✓ (3) $E = Pt = (0.5) \times (2) = 1$ kWh

21. A

The switch should be connected in the live wire L so that the iron can be cut off from high voltage when it is off.

The earth wire E should be connected to the metal case of the iron.

22. D

1 kWh = (1000 W) × (60 × 60 s) = 3.6×10^6 J

23. A

P : Earth wire $\Rightarrow$ Green/yellow $\Rightarrow Z$

Q : Neutral wire $\Rightarrow$ Blue $\Rightarrow Y$

R : Live wire $\Rightarrow$ Brown $\Rightarrow X$

24. C

One light bulb burnt out $\Rightarrow$ no current flow through that series

$\Rightarrow$ all bulbs in that string will go out

25. D

× A. S is on $\Rightarrow$ circuit completed $\Rightarrow$ iron will operate

× B. S is off $\Rightarrow$ circuit not completed $\Rightarrow$ iron will not operate

× C. High current $\Rightarrow$ fuse will blow $\Rightarrow$ circuit cut $\Rightarrow$ iron will not operate

✓ D. S is not in live wire $\Rightarrow$ the heating element is still at high voltage even when S is off.

26. C

kWh = kW · h = $(P)(t)$ = Energy

27. C

✓ (1) Presence of Earth wire connected to metal case
$\Rightarrow$ provides a path for conduction of current to the Earth
$\Rightarrow$ prevent electric shock

✓ (2) Current returns back to power supply via **neutral** wire instead.

× (3) Earth wire is not connected to mains socket, if neutral wire is broken, no current flows.

28. A

$I = \frac{I_o}{2} \Rightarrow$ resistance of appliance = resistance of wires = R

$\therefore$ equivalent resistance of the electrical appliance and the connecting wires = $2R$

By $V = IR$

If voltage of power supply : $V \rightarrow 2V$ and no change to the resistance

$\therefore$ It gives a current of I_o.

29. A

✓ (1) Current flows to the ground directly $\Rightarrow$ no current through the heating element $\Rightarrow$ short circuit $\Rightarrow$ current becomes very large $\Rightarrow$ fuse blows

× (2) Current flows through the heating element before reaching the metal case $\Rightarrow$ no increase in I

× (3) Heating element broken $\Rightarrow$ the circuit not completed $\Rightarrow$ no current flows through the fuse

30. D

Both the switch and the fuse should be connected to the live wire

31. A

✓ (1) By $R = \frac{V_r^2}{P_r}$, the rated power of X is halved of that of Y, thus the resistance is twice of that of Y.

× (2) Since $P = \frac{V^2}{R}$ $\therefore$ $P \propto V^2$ $\therefore$ when voltage is doubled, the power should be 4 times.

× (3) Since their resistances are not equal, the voltage across each heater will not be 110 V

32. D

Resistance of lamp = $6^2 / 12 = 3\ \Omega$

Total resistance = $3 / 2 + 3 = 4.5\ \Omega$

Current flow from the battery = $6 / 4.5 = 1.33$ A

Voltage across L_3 = $1.33 \times 3 = 4$ V

Voltage across L_1 and L_2 = $6 - 4 = 2$ V $\therefore$ A is not correct.

Current through L_1 = $1.33 / 2 = 0.67$ A $\therefore$ B is not correct.

Total power drawn from the battery = $6 \times 1.33 = 8$ W $\therefore$ C is not correct.

Total power dissipated in L_1 and L_2 = $1.33^2 \times 1.5 = 2.7$ W

Power dissipated in L_3 = $1.33^2 \times 3 = 5.3$ W $\therefore$ D is correct.

33. D

If the live and neutral wires are interchanged, then the switch would become connected on the neutral wire.

In this case, when the switch is off, the kettle will still stand at a high voltage.

However, the kettle would work properly when the switch is on.

34. C

Light bulb P is not under rated condition, since $P \propto V^2$

$\therefore$ $V \rightarrow \frac{1}{2}V \Rightarrow P \rightarrow \frac{1}{4}P$ $\therefore$ actual power of P is 20 W

Light bulb Q is under rated condition, thus the actual power is 80 W

Light bulb R is also under rated condition, thus the actual power is 40 W.

The brightest light bulb is Q and the dimmest light bulb is P.

35. B

Pin P is the earth pin which is connected to the metal case of the electric appliance.

When the live wire accidentally touches the metal case, the earth wire provides a low resistance path to conduct the current to the earth, thus prevent the electric shock of human bodies.

36. B

No. of washes per year = 260 Average time per wash = 1.8 hours

Total operating time = $260 \times 1.8 = 468$ hours

By $E = Pt$

$\therefore$ (250 kWh) = P (468 h)

$\therefore$ $P = 0.534$ kW = 534 W

37. B

Electric heater : $E = \frac{2500}{1000}\text{kW} \times \frac{30}{60}\text{h} = 1.25$ kWh

Television : $E = \frac{270}{1000}\text{kW} \times 5\text{ h} = 1.35$ kWh

Lamp : $E = \frac{150}{1000}\text{kW} \times 8\text{ h} = 1.20$ kWh

Since the cost is proportional to the amount of electrical energy used $\therefore$ $C_2 > C_1 > C_3$

38. C

Total electrical energy used = $1.2\text{ kW} \times 250\text{ h} + 0.25\text{ kW} \times 80\text{ h} + 0.15\text{ kW} \times 60\text{ h} = 329\text{ kW h}$

Cost of electricity = $329 \times \$\ 0.86 = \$\ 282.94$

39. D

× A. The kettle will operate no matter which fuse is installed.

× B. The kettle will not be short-circuited unless the live touches the neutral.

× C. The kettle will still work properly with the rated power of 900 W.

✓ D. Since the rated current = $900 / 220 = 4.09$ A. The fuse value of 15 A is too high. If the current exceeds the 4.09 A but less than 15 A, the fuse will not blow and the kettle may be damaged.

40. D

× (1) If the resistance is too large, the current would be too small, and the fuse would not blow.

✓ (2) If the appliance is short-circuited, the current would become very large and the fuse will blow.

✓ (3) If the rated value of the fuse is too small, then the rated current may exceed the fuse value and the fuse will blow.

41. A

Resistance of the '220 V, 50 W' light bulb $= \frac{(220)^2}{(50)} = 968\ \Omega$

Resistance of the '220 V, 100 W' light bulb $= \frac{(220)^2}{(100)} = 484\ \Omega$

Total equivalent resistance of the two light bulbs in series $= 968 + 484 = 1452\ \Omega$

Current drawn from the mains supply $= \frac{220}{1452} = 0.15$ A

42. B

According to the label, 600 revolutions indicate an electrical energy of 1 kWh, i.e. 3600 000 J.

For 24 revolutions, $E = 24 \times \frac{3600000}{600} = 144000$ J

Electric power : $P = \frac{E}{t} = \frac{144000}{2 \times 60} = 1200$ W

43. A

When S is closed, the $5R$ resistor is shorted. The equivalent resistance of the whole circuit is R.

When S is open, the $5R$ and R resistors are in series. The equivalent resistance of the whole circuit is $6R$.

By $P = \frac{V^2}{R} \propto \frac{1}{R}$ ∴ Power consumed in the mode of keeping warm $= 600 \times \frac{R}{6R} = 100$ W

44. C

Live wire : current drawn is 2 A
voltage is at high voltage of 220 V

Neutral wire : current is equal to that of live wire, i.e. 2 A
voltage is at low voltage of 0 V

Earth wire : no current through earth wire when operating, i.e. 0 A
no voltage in the earth wire, i.e. 0 V

45. B

Maximum power given by the mains socket without triggering the circuit breaker $= VI = 220 \times 15 = 3300$ W

Assume n light bulbs at most can be connected. ∴ $1100 + 550 + 100n = 3300$ ∴ $n = 16.5$

Thus, maximum number of light bulbs that can be connected = 16.

46. B

Resistance of each bulb $= \frac{V_r^2}{P_r} = \frac{(220)^2}{(30)} = 1613\ \Omega$

Total equivalent resistance for three bulbs in series $= 1613 \times 3 = 4840\ \Omega$

Total power dissipated $= \frac{V^2}{R} = \frac{(220)^2}{(4840)} = 10$ W

47. B

Total current given out by the mains supply $= 0.4 \times 2 = 0.8$ A

Total power given out by the mains supply : $P = VI = (220)(0.8) = 176$ W

Total energy consumed : $E = Pt = (0.176\ \text{kW}) \times (5\ \text{h}) = 0.88$ kWh

48. B

By $R = \frac{V_r^2}{P_r}$

By $(6) = \frac{V_r^2}{(24)}$ ∴ $V_r = 12$ V ∴ Rated voltage of the 6 Ω light bulb is 12 V.

By $(4) = \frac{V_r^2}{(9)}$ ∴ $V_r = 6$ V ∴ Rated voltage of the 4 Ω light bulb is 6 V.

As the two light bulbs are in parallel, they must have the same applied voltage V.

If the applied voltage is 12 V, then the 4 Ω light bulb would be burnt, thus the applied voltage should only be 6 V.

Equivalent resistance of the circuit : $R = \frac{6 \times 4}{6+4} = 2.4\ \Omega$

Current delivered from the power supply : $I = \frac{V}{R} = \frac{6}{2.4} = 2.5$ A

OR

Current delivered from the power supply : $I = \frac{6}{6} + \frac{6}{4} = 2.5$ A

49. D

Y is live as switch and fuse are on the live wire.

X is neutral to complete the circuit.

Z is the earth that is connected to the metal case of the appliance.

50. A

When S_1 and S_2 are closed and S_3 is open, the two resistors are in parallel, equivalent resistance is $\frac{1}{2}R$.

When S_1 and S_2 are open and S_3 is closed, the two resistors are in series, equivalent resistance is $2R$.

The equivalent resistance is increased 4 times.

By $P = \frac{V^2}{R}$, as power is inversely proportional to the resistance, the power should become $\frac{1}{4}$.

Thus the power is $0.25P$.

51. D

× (1) By $P = VI$ $\therefore$ $(1150) = (220)\,I$ $\therefore$ $I = 5.23$ A

✓ (2) Percentage of energy carried by the microwave $= 750 / 1150 = 65\%$

✓ (3) Wavelength : $\lambda = v/f = (3 \times 10^8) / (2450 \times 10^6) = 0.12$ m

52. D

× A. When S is closed, current would flow from live to the metal case and then to earth as it is a shorted path, thus no current would flow through the heating element and the kettle will not operate.

× B. As the current would not flow through the heating element and the fuse, the fuse would not blow.

× C. As there is no current flowing through the heating element, the heating element would not burn out.

✓ D. When S is open, current can still flow through the live wire to the metal case, and then to the earth wire to complete the circuit.

53. B

Rated current $= \dfrac{P_r}{V_r} = \dfrac{12}{6} = 2$ A

Voltage across the two resistors $= 9 - 6 = 3$ V

Equivalent resistance of the two resistors $= \dfrac{V}{I} = \dfrac{3}{2} = 1.5\ \Omega$

As the two resistors are in parallel : $\dfrac{R}{2} = 1.5$ $\therefore$ $R = 3\ \Omega$

54. A

Electrical energy supplied to the light bulb $= P\,t = (2)\,(10 \times 60) = 1200$ J

Heat energy given out by the light bulb $= m\,c\,\Delta T = (0.050) \times (4200) \times (4.5) = 945$ J

Light energy given out by the light bulb $= 1200 - 945 = 255$ J

55. D

Total power given out by the battery $= VI = (6) \times (2) = 12$ W

For each light bulb to give normal brightness, the power given out by each light bulb is 1.5 W.

Total number of light bulbs in the circuit $= \dfrac{12}{1.5} = 8$

56. B

× (1) Voltage dropped below 200 V $\Rightarrow$ all light bulbs would become dimmer

× (2) Smaller current $\Rightarrow$ all light bulbs become dimmer

✓ (3) As $R = \dfrac{V^2}{P}$, for same rated power 5 W but lower rated voltage, the new bulb has smaller resistance

As $P = I^2 R$ for light bulbs in series, $P \propto R$ $\therefore$ the new bulb has less power than the other bulbs

57. C

× (1) As more lamps are switched on in parallel, the equivalent resistance should decrease.

✓ (2) As more power is given to the lamps, the total power consumption increases.

✓ (3) As the equivalent resistance decreases, more current is drawn from the supply.

58. A

✓ (1) Fuse should be made of metal with low melting point so that it would be melted by the heating effect of the excess current.

✓ (2) Copper has a high melting and cannot be melted easily, thus even the current exceeds the rated current of the fuse, copper would not be melted and blown.

× (3) Both the fuse and the copper wire have negligible resistance, as they are connected in series to the appliance, they would not cause short circuit of the appliance.

59. C

For the bulb being fully lit,

(1) Number of bulbs in each series path $= \dfrac{24}{12} = 2$

(2) Current flowing through each parallel circuit = current flowing through each bulb $= \dfrac{P}{V} = \dfrac{6}{12} = 0.5$ A

Number of parallel circuit connected to power supply $= \dfrac{2}{0.5} = 4$

$\therefore$ Total number of bulbs $= 2 \times 4 = 8$

OR

Power given out by the power supply $= VI = (24) \times (2) = 48$ W

Number of light bulbs $= \dfrac{48}{6} = 8$

60. A

✓ (1) When they work at their rated values, power given out by the '200 V, 100 W' light bulb is 100 W which is greater than the 40 W given out by the '200 V, 40 W' light bulb.

✓ (2) By $P = VI$, as the power given out by the '200 V, 100 W' light bulb is greater, the current drawn is greater.

× (3) By $R = V_r^2 / P_r$, as the power given out by the '200 V, 100 W' light bulb is greater, its resistance is smaller.

61. A

✓ (1) Fuse should be installed in the live wire, so that the appliance is cut off from high voltage when the fuse is blown.

× (2) Switch should also be connected to the live wire, so that the appliance is cut off from high voltage when the switch is off.

× (3) Since household circuit is an a.c. circuit, current flows from L to N and from N to L alternately.

62. B

× (1) By $R = V_r^2 / P_r$, as the rated power P_r of the '200 V, 100 W' light bulb is greater, its resistance is smaller.

× (2) When they are connected in series, the current flowing through each of them must be the same.

✓ (3) As the resistance of the '200 V, 100 W' light bulb is smaller, by $P = I^2 R$, same current I in series, thus, $P \propto R$, therefore, the power dissipated is smaller.

63. D

× A. The kettle will operate no matter which fuse is installed.

× B. The kettle will not short-circuited unless the live touches the neutral.

× C. The kettle will still work properly with the rated power of 900 W.

✓ D. Since the rated current = 900 / 220 = 4.09 A ∴ the fuse value of 15 A is too high.
If the current exceeds 4.09 A but less than 15 A, the fuse will not blow and the kettle may be damaged.

64. C

Total electrical energy used = 1.2 kW × 250 h + 0.25 kW × 80 h + 0.15 kW × 60 h = 329 kW h

Cost of electricity = 329 × $ 0.86 = $ 282.94

65. C

If the insulation at X is worn out, once the switch is closed,
current would flow from the Live wire through the metal case to the Earth wire.
As the resistance of the metal case is negligible, current would be very large and the fuse would blow.

66. C

✓ (1) If X and Y are short circuited, current would not flow through the resistor and becomes very large.

✓ (2) If Y and Z are short circuited, current would not flow through the resistor and becomes very large.

× (3) If X and Z are short circuited, current must still flow through the resistor and would not be too large.

67. B

A microwave oven normally has a power around 1000 W.
Other appliances : electric fan, fluorescent lamp and TV, have power much less than 1000 W.

68. C

In parallel circuit, current supplied by the mains is the sum of current in each parallel path.
Current cannot be reduced by using parallel circuit.

69. D

× A. The frequency of the a.c. mains does not affect the working of an electric iron.

× B. As the applied voltage is smaller than that in Hong Kong, thus the power cannot be the same.

× C. As the applied voltage is smaller than that in Hong Kong, thus the power cannot be higher.

✓ D. For the same resistance of an appliance : $P = V^2 / R$ ∴ $P \propto V^2$
Since the mains voltage of country X is lower, the power given out is smaller, thus the iron is colder.

70. A

$E = P t$ = (0.0015 kW) × (16 h × 30) = 0.72 kW h

Carbon dioxide emission = 0.72 × 0.8 = 0.576 kg

71. D

× A. Fuse should be installed in the live wire.

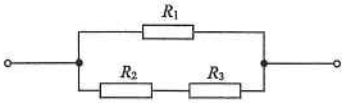
× B. The fuse is still required to limit the current to avoid overheating.
For electrical appliance with double insulation, there is no metal case, thus, earth wire is not needed.

× C. For a heater of rating '220 V, 1500 W', the rated current : I_r = 1500 / 220 = 6.82 A
A 5A fuse is not suitable as it would be blown when the heater is switched on.

✓ D. Fuse has a low melting point that it can melt and break the circuit once current exceeds the rated current.
Thus, its melting point must be lower than that of copper wire.

72. B

Since the voltage of R_1 is equal to the sum of voltage of R_2 and R_3,
R_1 should work under rated power to give P_1 = 12 W.
Since the voltage of R_2 is halved of R_1,
by $P = V^2 / R \propto V^2$, the power of R_2 is one-fourth of R_1



$P_2 = 12 \times \left(\frac{1}{2}\right)^2 = 3$ W

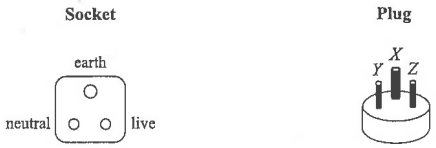
Since the voltage of R_3 is equal to that of R_2, thus $P_3 = P_2 = 3$ W
Total power = 12 + 3 + 3 = 18 W

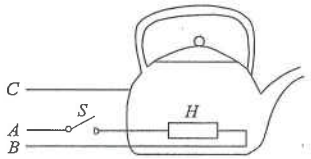
The following list of formulae may be found useful :

Resistance and resistivity	$R = \frac{\rho l}{A}$
Resistors in series	$R = R_1 + R_2$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
Power in a circuit	$P = IV = I^2R$
Energy transfer during heating or cooling	$E = mc\Delta T$
Energy transfer during change of state	$E = l\Delta m$

Part A : HKCE examination questions

1. < HKCE 1981 Paper I - 8 >





Electric kettle

The above figure shows a 220 V supply socket, a 3-pin plug, and an electric kettle with a rating : '220V 1.65 kW'. The kettle has 3 wires *A*, *B*, *C* leading from it. Wire *A* is joined through a switch *S* to the heating element *H* of the kettle ; wire *B* completes the circuit of the kettle ; wire *C* is joined to the metal case of the kettle.

(Given : Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$)

(a) (i) To which of the pins *X*, *Y*, *Z* of the plug should each of the wires *A*, *B*, *C* of the kettle be connected ? (3 marks)

(ii) What is the function of the 'earth' terminal in the socket ? (1 mark)

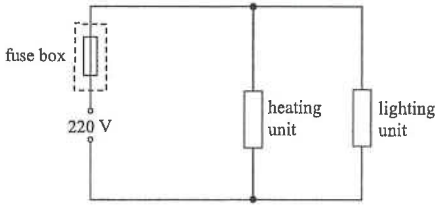
1. (b) (i) A 15 A fuse is connected to the socket. Which line : earth, neutral and live, should the fuse be placed ? (1 mark)

(ii) Find the maximum number of kettles that can be joined in parallel to the socket without blowing the fuse. (3 marks)

(c) (i) If the efficiency of the kettle is 80%, how long will it take to heat 1 kg of water from 20°C to 100°C ? (4 marks)

(ii) If the cost of electricity is $0.80 per kWh, how much does this heating process cost ? (3 marks)

2. < HKCE 1983 Paper I - 7 >



A household electric circuit consists of a heating unit (220 V, 1100 W) and a lighting unit (220 V, 220 W) connected in parallel to the mains of 220 V as shown in the above figure.

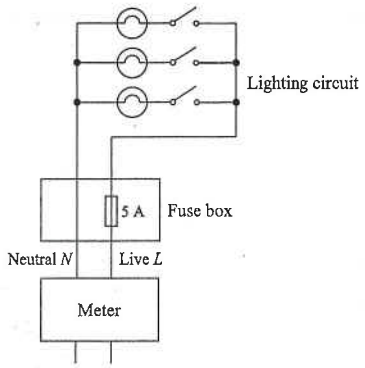
(a) Find the maximum current drawn from the mains. (2 marks)

(b) Is a 5 A fuse suitable for use in the fuse box ? Explain briefly. (2 marks)

(c) If electrical energy costs $0.90 per kWh and the whole system is switched on for 150 hours, what will be the cost of the electricity used ? (2 marks)

3. **< HKCE 1986 Paper I - 7 >**

The figure shows a simplified system of a 220 V domestic circuit. N and L denote the neutral and live wires respectively.



(a) Give a reason why the lamps are all connected in parallel instead of in series. (2 marks)

(b) The light bulbs of the circuit shown in the above figure are all marked "60 W 220 V". Suppose that all the light bulbs are switched on. (5 marks)

(i) What is the total resistance of the lighting circuit ?

(ii) What is the total current drawn from the power supply ?

(c) (i) Explain the use of the fuse in the circuit. (2 marks)

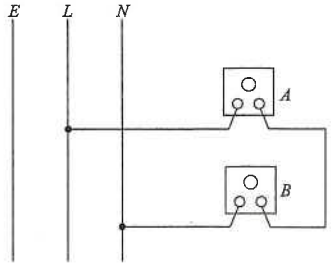
(ii) Give a reason why the switches should be connected to the live wire L instead of to the neutral wire N. (2 marks)

(iii) What physical quantity does the meter measure ? (2 marks)

(d) The household voltage supply in Hong Kong has changed from 200 V a.c. to 220 V a.c. in 1995. Give one reason for the change. (2 marks)

4. **< HKCE 1988 Paper I - 7 >**

Given socket A and socket B, an unqualified electrical technician wires the two sockets to the live L, the neutral N, the earth E of the 220 V mains supply for a heater rated at "220 V, 1000 W" and a cooker rated at "220 V, 800 W" as shown in the figure below. (The sockets are viewed from the front.)



(a) (i) If either one of these appliances is plugged into one of the sockets, would there be any current drawn from the mains with the switch of the appliance on ? Explain briefly. (2 marks)

(ii) If both appliances are plugged into the sockets, would the appliances work at the rated power (1000 W and 800 W) with switches on ? Explain briefly. (2 marks)

(iii) Draw a diagram to show how the two sockets should be connected to the live, the neutral and the earth of the mains supply with a fuse placed at a proper position. (4 marks)

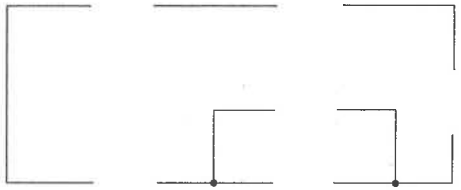
(b) Suppose the heater and the cooker are switched on in the correct wiring circuit for 2 hours, calculate

(i) the total current drawn from the mains supply, and (3 marks)

(ii) the total cost of electricity if one kilowatt-hour of electric energy costs $0.90. (2 marks)

5. **< HKCE 1992 Paper I - 5 >**

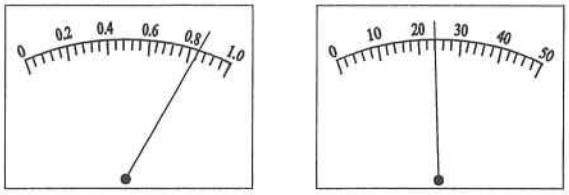
A student uses the following components to measure the resistance of a light bulb : A battery, an ammeter, a voltmeter, a switch, a variable resistor and the light bulb. An incomplete circuit for the experiment is shown below :



(a) On the above figure, use suitable circuit symbols to complete the circuit. Indicate on your diagram the positive terminals of the ammeter and voltmeter with "+" signs. (5 marks)

(b) What is the function of the variable resistor in the circuit ? (2 marks)

(c) The below figure shows the result obtained in the experiment.



Voltmeter (0 – 1 V) Ammeter (0 – 50 mA)

(i) What is (1) the voltmeter reading, (2) the ammeter reading ? (2 marks)

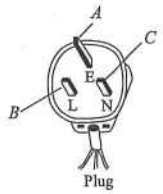
(ii) Calculate the resistance of the light bulb. (2 marks)

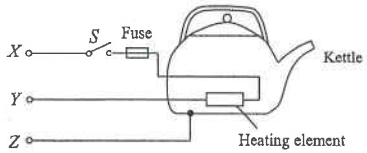
(d) The rating of the light bulb is "220 V, 110 W".

(i) Calculate the resistance of the bulb when it is working at its rated value. (2 marks)

(ii) Explain why the resistance found in (d)(i) is much greater than that found in (c)(ii). (2 marks)

6. **< HKCE 1998 Paper I - 4 >**





The above Figure shows a 3-pin plug and a kettle.

(a) To which of the pins *A*, *B* and *C* of the plug should each of the wires *X*, *Y* and *Z* of the kettle be connected ? (2 marks)

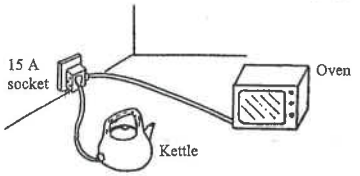
(b) (i) Explain why it is safer to have pin *A* of the plug longer than the other two pins. (2 marks)

(ii) Explain why switch *S* of the kettle is connected in wire *X* instead of wire *Y*. (2 marks)

(c) The rating of the kettle is '220 V, 2000 W'.

(i) If the kettle is switched on for half an hour, calculate the cost of electricity.
(Given : One kilowatt-hour of electricity costs $0.9.) (2 marks)

(ii)



A housewife plugs the kettle and an oven of rating '220 V, 2500 W' into a 15 A socket as shown in the above figure. Explain why this connection is dangerous. Show your calculations. (3 marks)

(d) A student makes the following note in his book :

In case either wire *X* or *Y* touches the metal case of the kettle accidentally, the kettle will stop working.

Explain whether the student's note is correct. (3 marks)

7. **< HKCE 1999 Paper I - 1 >**

Figure 1

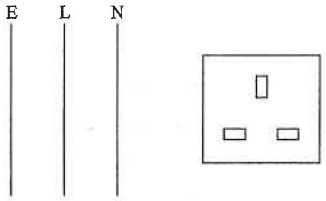


Figure 1 shows the front view of a socket and the earth (E), live (L) and neutral (N) wires of the 220 V mains supply.

(a) On Figure 1, show how the socket is connected to the mains supply. (2 marks)

(b)

Figure 2

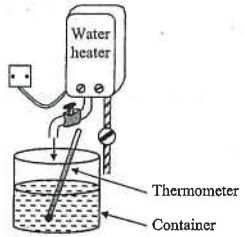
Model No. : CS301
220 V 50 Hz
2500 W

Figure 2 shows the label attached to an electrical appliance. If the appliance is switched on for 150 hours in a month, calculate the cost of electricity. (Given : 1 kWh of electricity costs $ 0.87.) (2 marks)

8. **< HKCE 2001 Paper I - 9 >**

(a)

Figure 1



Mary wants to estimate the efficiency of an electric water heater in her kitchen. She uses a container to collect the water and a thermometer to measure the temperature (see Figure 1). She finds that when the heater is switched on, 1.6 kg of water at 23°C is heated to 67°C in one minute. The rating value of the heater is '220 V, 6000 W' and the specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$.

(i) Find the energy absorbed by the 1.6 kg of water in one minute. (2 marks)

(ii) Estimate the efficiency of the heater. (3 marks)

(iii) State one reason to explain why the efficiency found in (ii) is less than 100%. (1 mark)

8. (b)

Figure 2

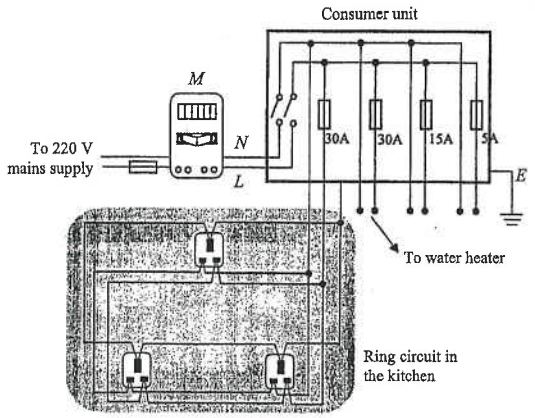


Figure 2 shows a household electrical wiring circuit. The mains cable (containing live and neutral wires) is connected to a consumer unit via a meter *M*. At the consumer unit, the wires branch out into a number of parallel circuits. Figure 2 also shows the power circuit in the kitchen. It is in the form of a ring circuit with three sockets tapped off from the ring.

(i) Name the meter *M*. What physical quantity does the meter record ? (2 marks)

(ii) The following appliances are connected to the ring circuit in the kitchen :

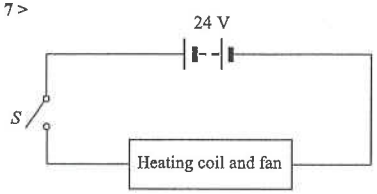
Appliances	Rating
a refrigerator	220 V , 600 W
an electric kettle	220 V , 2000 W
an oven	220 V , 1500 W

If the appliances are all switched on, find the total current drawn from the mains supply. (3 marks)

(iii) Explain why the water heater mentioned in part (a) is not connected to the sockets in the rings circuit but directly connected to the mains via a separate circuit. (2 marks)

(iv) State one advantage of the ring circuit arrangement. (2 marks)

9. **< HKCE 2002 Paper I - 7 >**



In a science project competition, a student constructs a hand-dryer. He connects an electric fan of rating '20 W, 24 V' and a heating coil to a 24 V power supply as shown in the Figure 1. When switch *S* is closed, the fan will operate at its rated value.

(a) Are the fan and the heating coil connected in series or in parallel ? Explain your answer. (2 marks)

(b) If the output power of the heating coil is 200 W, find

(i) the operating resistance of the heating coil,

(ii) the total current drawn from the power supply when *S* is closed. (4 marks)

10. **< HKCE 2003 Paper I - 8 >**

Figure 1

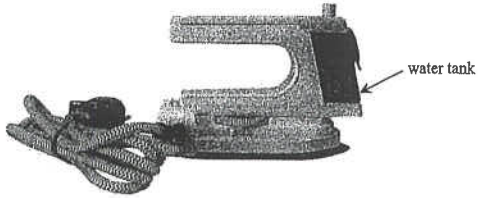


Figure 1 shows a travel steam iron with a rated power output of 1100 W. The water tank in the iron is filled with water. When the iron is turned on, water drips continuously from the tank to a hot plate inside the iron, generating steam for ironing clothes. Assume the initial temperature of the water drops is 20°C.

Given : Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$,
specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}.

(a) Calculate the energy required to vaporize 1 kg of water at 20°C into steam. (2 marks)

10. (b) Assume that 80% of the power output of the iron is used to generate steam. Estimate the maximum mass of steam that can be generated by the iron in 1 s. (2 marks)

(c) The iron is designed to operate at 220 V or 110 V with the same power output of 1100 W.

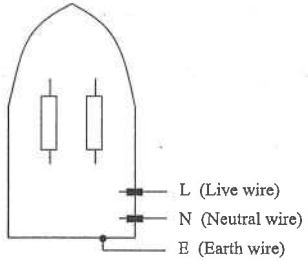
(i) In each of the following cases, find the resistance of the heating element of the iron :

(1) when operating at 220 V,

(2) when operating at 110 V. (3 marks)

(ii)

Figure 2



The heating element of the iron consists of two identical resistance wires as shown in Figure 2.

(1) Draw **two** diagrams to show how the resistance wires are connected when the iron is operating at 220 V and at 110 V respectively. (3 marks)

(2) What is the resistance of each resistance wire ? (1 mark)

(iii) A tourist switches the iron to the 220 V mode but connects it to a 110 V supply. Explain whether the iron can function normally. (3 marks)

11. **< HKCE 2006 Paper I - 6 >**

Rated Capacity	24.1 litres
Heating time (15°C → 65°C)	24.3 minutes

The above Figure shows the energy label of a water heater from which some information is listed in the above Table.

Given : mass of 1 litre of water = 1 kg,

specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

(a) The heating element of a water heater is usually installed on the lower position of the water tank. Suggest one reason for this design. (1 mark)

(b) Using the information in the above Table,

(i) estimate the energy required to heat a full tank of water from 15°C to 65°C, (2 marks)

(ii) hence estimate the current drawn by the water heater when it is operating at 220 V. (3 marks)

(c) Explain why thick wires are used to connect the water heater to the mains supply. (2 marks)

12. **< HKCE 2008 Paper I - 7 >**

Figure 1 shows a ceiling lamp in Jack's home. The lamp has two filament light bulbs, each rated "220 V 40 W". The lamp is turned on or off by a switch (see Figure 2) on the wall.

Figure 1

Figure 2

(a) Give **two advantages** of connecting the two light bulbs to the 220 V mains supply in parallel. (2 marks)

(b) Explain why the switch should be connected to the live wire of the mains supply. (2 marks)

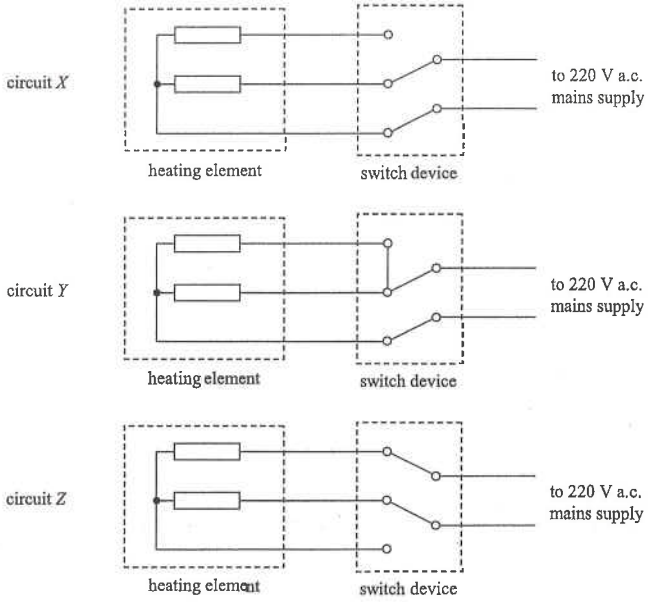
(c) Jack decides to replace each filament light bulb with an energy saving bulb of the same brightness. The Table below shows the details of the two kinds of bulbs. Considering the price of the bulbs and the electricity fee, find the total money saved **per energy saving bulb** after operating for 4000 hours.

		Price per bulb	Power	Electricity fee
	filament light bulb	$ 5	40 W	$ 0.95 / kW h
	energy saving bulb	$ 35	8 W	

(3 marks)

13. **< HKCE 2010 Paper I - 9 >**

A hair dryer with a plastic case has three settings of power output : high, medium and low. The settings are selected by the use of a switch device. The Figure below shows the circuits of these three settings in random order. All the resistors in the heating element have the same resistance of 50 Ω. The hair dryer is connected to 220 V a.c. mains supply.



(a) Find the power delivered by circuit *Y*. (3 marks)

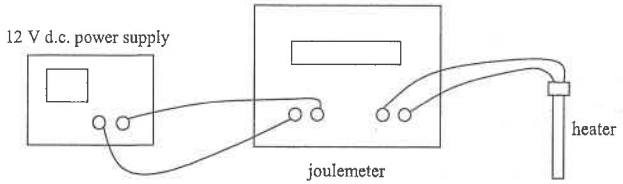
(b) Fill in *X*, *Y* and *Z* in the appropriate spaces in the below Table. (1 mark)

Power output settings	Circuit
Low	
Medium	
High	

(c) Explain why the hair dryer does not need an earth wire. (1 mark)

Part B : HKDSE examination questions

14. **< HKDSE Practice Paper IB - 9 >**



A 12 V heater is operated under a steady d.c. voltage of 12 V. The energy consumed by the heater in 2 minutes is measured by a joulemeter as shown in the Figure. The initial and final readings of the joulemeter are 126 J and 2525 J respectively.

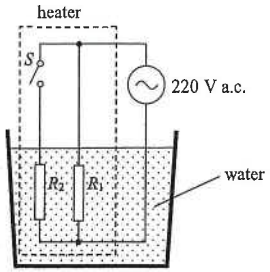
(a) Estimate the electrical power of the heater. (2 marks)

(b) Hence, find the current through the heater. (2 marks)

(c) A 5 A fuse is installed in the power supply. Explain whether the fuse will blow if another identical heater is connected in parallel with the original heater. (2 marks)

15. **< HKDSE 2012 Paper IB - 8 >**

In the circuit shown in the Figure, resistors R_1 and R_2 represent the heating elements in a heater using mains supply. Both resistors are immersed in water.



The heater can be operated in two modes, namely, heating and keeping warm, and it is controlled by the switch *S*. The power consumed by the heater in the heating mode is 550 W and in the mode of keeping warm is 88 W. The mains voltage is 220 V a.c.

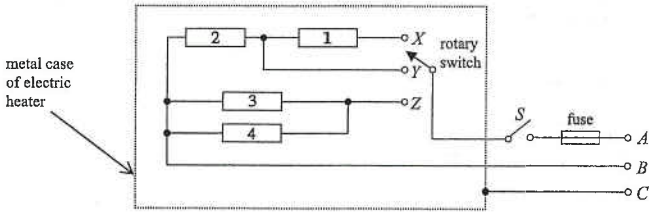
(a) In which mode is the heater operating when switch *S* is open ? (1 mark)

(b) Find the resistance of R_1. (2 marks)

(c) When switch *S* is closed, calculate the current passing through resistor R_2. (3 marks)

16. **< HKDSE 2014 Paper IB - 8 >**

The Figure shows the schematic diagram of an electric heater consisting of four identical heating elements, each having a rated value of '500 W 220 V'. A user can use the rotary switch to select one of the three modes of operation *X*, *Y*, *Z*. Wires *A*, *B*, *C* from the heater are connected to the 220 V a.c. mains via a 3-pin plug.



(a) Find the resistance *R* of a heating element. (1 mark)

16. (b) What is the total power dissipated when mode *X* is selected ? Assume that the resistance of each heating element remains unchanged. (2 marks)

(c) Without the need of calculations, explain which mode of operation has the largest total power dissipation. (2 marks)

(d) (i) If fuses 3 A, 5 A and 13 A are available, determine which will be the most suitable to limit an excess current. Show your work. (3 marks)

(ii) A student claims that since a.c. is used for the heater, the switch *S* can be installed in either wire *A* or wire *B*. Comment on this claim. (2 marks)

(iii) If a fault resulted in the live wire having contact with the metal case of the heater, which wire, *A*, *B* or *C*, could prevent an electric shock of a person touched the case of the heater ? Explain. (2 marks)

17. **< HKDSE 2018 Paper IB - 8 >**

(a) Figure 1 shows the schematic diagram of an electric heater which can operate in two modes, namely, 'heating' and 'keeping warm'. The heating elements of resistances $4R$ and R are connected to the mains supply via a 3-way switch with its two poles tied together. That is, both poles can be connected to one of the three pairs of terminals *X*, *Y* or *Z*.

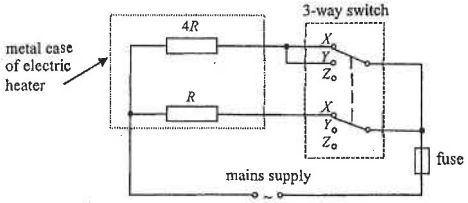


Figure 1

(i) To which pairs of terminals, *X*, *Y* or *Z*, should the switch connect to when the heater is in 'heating' mode ? (1 mark)

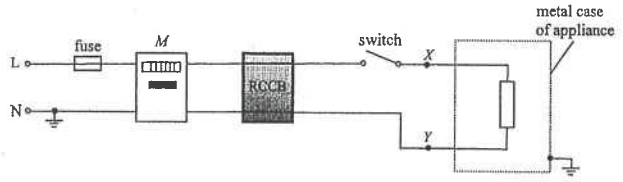
17. (a) The power consumed by the heater in 'heating' mode is 800 W.

(ii) Calculate the current drawn from the 220 V mains supply when the heater is in 'heating' mode. (2 marks)

(iii) Find the power consumed by the heater in the mode of 'keeping warm'. (3 marks)

(b) Figure 2 shows a simplified domestic circuit connected to an electrical appliance via a fuse, a meter *M*, a residual current circuit breaker (RCCB) and a switch.

Figure 2



(i) What physical quantity does the meter *M* record ? (1 mark)

(ii) An RCCB is a kind of safety device that cuts off the supply automatically whenever there is a small difference between the currents in the live (L) and neutral (N) wires. State, in each of the following situations, which device(s) will respond (i.e. the fuse blows and/or the RCCB cuts off the supply).

(1) A short circuit occurs between points *X* and *Y*. (1 mark)

(2) A short circuit occurs between point *Y* and the metal case of the appliance. (1 mark)

There is question in next page

Question Solution

1. (a) (i) $A \longrightarrow Y$ [1]

$B \longrightarrow Z$ [1]

$C \longrightarrow X$ [1]

(ii) To prevent electric shock if there is any leakage of electricity to the metal case. [1]

OR

To prevent electric shock by conducting the current to the Earth through the earth wire. [1]

(b) (i) Live [1]

(ii) Rated current of each kettle $= \frac{P}{V}$ [1]

$= \frac{1650}{220} = 7.5\ \text{A}$ [1]

Maximum number of kettle $= \frac{15}{7.5}$

$= 2$ [1]

(c) (i) Actual power given to the water $= 1650 \times 80\% = 1320\ \text{W}$ [1]

Energy required to heat 1 kg of water $= (1) \times (4200) \times (100 - 20) = 336\,000\ \text{J}$ [1]

Time taken $= \frac{336000}{1320}$ [1]

$= 255\ \text{s}$ [1]

(ii) $E = 1.65\ \text{kW} \times \frac{255}{3600}\ \text{h}$ [1]

$= 0.117\ \text{kW h}$ [1]

OR

$E = \frac{336000}{3600000} \times \frac{100}{80}$ [1]

$= 0.117\ \text{kW h}$ [1]

Cost $= 0.117 \times 0.80$

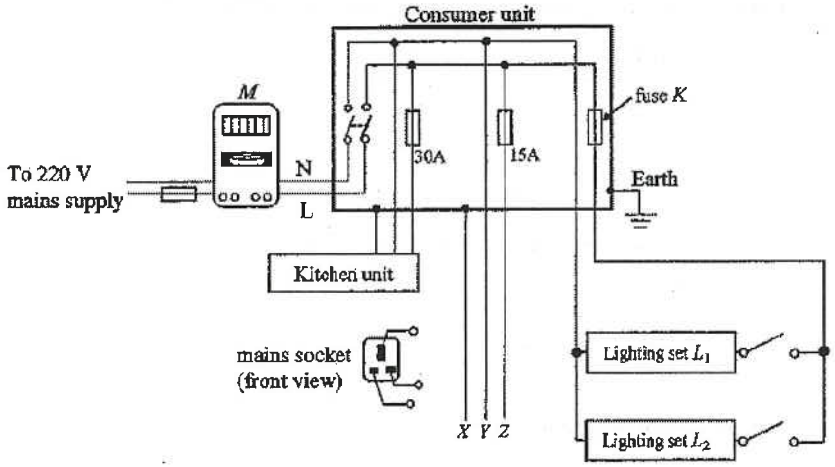
$= \$\ 0.0936$ < accept $ 0.0933 > [1]

2. (a) Total power $= 1100 + 220 = 1320\ \text{W}$ [1]

$\therefore I = \frac{P}{V} = \frac{1320}{220} = 6\ \text{A}$ [1]

18. <HKDSE 2019 Ppaper-IB-8>

Figure 8.1 shows a household electrical wiring circuit. The mains cable (containing live wire L and neutral wire N) is connected to a consumer unit via a kilowatt-hour meter *M*. At the consumer unit, the wires branch out into a number of parallel circuits.



ure 8.1

(a) Indicate on Figure 8.1 how the mains socket should be connected to wires *X*, *Y* and *Z*. (1 mark)

(b) Lighting sets L_1 and L_2 of power ratings 300 W and 450 W respectively are connected in parallel to the branch with fuse *K*.

(i) State one advantage of connecting L_1 and L_2 in parallel instead of in series to the branch. (1 mark)

(ii) If fuses marked 3 A, 5 A, 10 A and 13 A are available, which one is the most suitable to be fuse *K*? Explain your choice. (3 marks)

(c) The kitchen unit includes the following electrical appliances:

	rating	effective time of operation at rated value per day
a refrigerator	220 V, 500 W	8 hours
an electric kettle	220 V, 2000 W	0.5 hour
an induction cooker	220 V, 3000 W	2 hours

How much should be paid per day to run these appliances if 1 kW h of electrical energy costs $0.9 ? (3 marks)

2. (b) No ! [1]

The fuse will blow. [1]

(c) $E = 1.32\ \text{kW} \times 150\ \text{h} = 198\ \text{kW h}$ [1]

Cost $= 198 \times 0.9 = \$\ 178.2$ [1]

3. (a) Any **ONE** of the reasons below : [2]

* Each lamp can be switched on and off independently
* Even if one lamp is burnt, the other lamps can still operate properly
* The voltage across each lamp is 220 V to give out rated power.

(b) (i) Resistance of each light bulb $= \frac{V^2}{P}$ [1]

$= \frac{(220)^2}{(60)} = 807\ \Omega$ [1]

Total resistance $= \frac{807}{3}$

$= 269\ \Omega$ [1]

(ii) Total current $= 3 \times \frac{60}{220}$ [1]

$= 0.818\ \text{A}$ [1]

(c) (i) To prevent the overloading of the wire. [2]

OR

To limit the flow of current in the circuit. [2]

(ii) To ensure that the lamps are cut off from live when the switches are open. [2]

(iii) Energy [2]

(d) Either **ONE** of the followings : [2]

* To match with the international standard
* To increase the power output

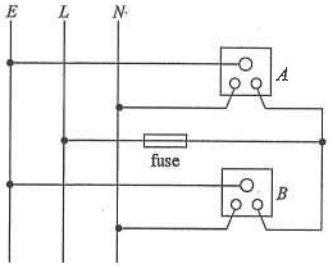
4. (a) (i) No ! [1]

Sockets *A* and *B* are connected in series to the mains. [1]

(ii) No ! [1]

When both appliances are plugged in, the voltage across each socket is less than 220 V. [1]

4. (a) (iii)



[4]

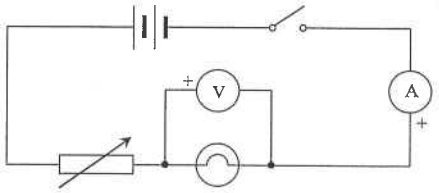
(b) (i) $I = \frac{P}{V}$ [1]

Total current $= \frac{1000}{220} + \frac{800}{220} = 8.18\ \text{A}$ [2]

(ii) Energy used $= (1.0 + 0.8)\ \text{kW} \times 2\ \text{h} = 3.6\ \text{kW h}$ [1]

Cost $= 3.6 \times 0.9 = \$\ 3.24$ [1]

5. (a)



< Battery, ammeter, switch, variable resistor and light bulb in series with correct symbols > [3]

< Voltmeter in parallel with the light bulb > [1]

< +ve terminal of voltmeter and ammeter correct > [1]

(b) The variable resistor is used to vary the current flowing through the bulb. [2]

(c) (i) (1) 0.84 V [1]

(2) 24 mA [1]

(ii) $R = \frac{V}{I} = \frac{0.84}{0.024} = 35\ \Omega$ [2]

(d) (i) Operating resistance $= \frac{V^2}{P} = \frac{(220)^2}{(110)}$ [1]

$= 440\ \Omega$ [1]

(ii) When the bulb is working at its rated value, its temperature is much higher, [1]

so resistance increases. [1]

6. (a) X is connected to B.
Y is connected to C.
Z is connected to A.
< 1 mark for one of them correct > [1]
< 1 mark for the other two correct > [1]

(b) (i) To ensure the metal case of the kettle is earthed
before the heating element is connected to the live wire. [2]
OR
The long pin opens the shutter that blocks the other two apertures
to prevent accidental insertion of metal objects. [2]

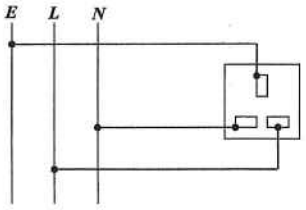
(ii) S is connected in wire X
because the heating element will be cut off from the live wire when S is switched off. [2]
OR
If S is connected in wire Y,
the heating element will still be at live wire even when S is switched off. [2]

(c) (i) $E = 2\text{ kW} \times 0.5\text{ h} = 1\text{ kW h}$ [1]
Cost $= \$0.9 \times 1 = \$0.9$ [1]

(ii) Current drawn from the mains supply
$= \frac{2000}{220} + \frac{2500}{220}$ [2]
$= 20.5\text{ A}$
Since the current exceeds 15 A, the connection is dangerous and the fuse will blow. [1]

(d) If wire X touches the case, a short circuit will be set up between the live wire and the earth, [1]
the fuse will blow and the kettle will stop working. [1]
If wire Y touches the metal case, the circuit is still completed, so the kettle will continue to work. [1]

7. (a)



< For earth wire > [1]
< For neutral and live wire > [1]

(b) Energy used $= 2.5\text{ kW} \times 150\text{ h} = 375\text{ kW h}$ [1]
Cost of electricity $= 375 \times 0.87 = \$326$ < accept \$326.25 > [1]

8. (a) (i) $E = mc\Delta T$ [1]
$= (1.6) \times (4200) \times (67 - 23) = 296\,000\text{ J}$ < accept 295 680 J or 296 kJ > [1]

(ii) Power output $= \frac{E}{t} = \frac{295680}{60} = 4930\text{ W}$ < accept 4928 W > [1]

Efficiency $= \frac{\text{Power output}}{\text{Power input}}$ [1]

$= \frac{4928}{6000} \times 100\% = 82.1\%$ < accept 82.2% > [1]

(iii) Any **ONE** of the following : [1]
* Some energy is lost to the surroundings
* Some energy is absorbed by the container

(b) (i) It is a kilowatt-hour meter. [1]
It measures the electrical energy used. [1]

(ii) Total power $= 600 + 2000 + 1500 = 4100\text{ W}$ [1]

$I = \frac{P}{V} = \frac{4100}{220}$ [1]
$= 18.6\text{ A}$ [1]

(iii) The water heater draws a large current from the mains supply. [1]
If other electric appliances are connected together, overloading may occur. [1]

(iv) Any **ONE** of the following : [2]
* If the ring circuit is broken at one point, the ring circuit can still function.
* Current is divided into two halves via two paths, thus thinner cables can be used.
* Since current is divided into two halves, the chance of overloading is reduced.

9. (a) The fan and the heating coil are connected in parallel. [1]
So that they can operate at their rated values. [1]

(b) (i) $R = \frac{V^2}{P}$ [1]
$= \frac{24^2}{200} = 2.88\ \Omega$ [1]

(ii) $I = \frac{P}{V}$ [1]
$= \frac{20 + 200}{24} = 9.17\text{ A}$ [1]

10. (a) $E = m l_f + m c \Delta T$

$= (1)(2.26 \times 10^6) + (1)(4200)(100 - 20)$ [1]

$= 2\,596\,000$ J [1]

(b) Useful energy output in 1 s $= (1100)(1) \times 80\% = 880$ J [1]

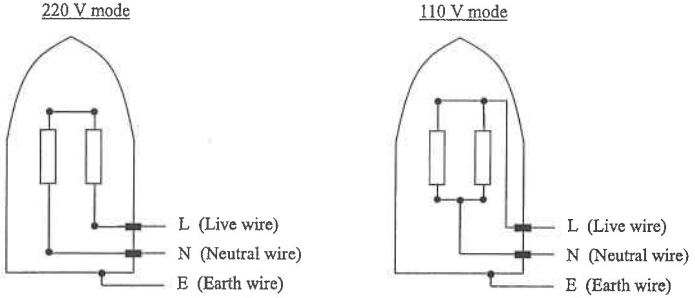
Maximum mass of steam generated in 1 s $= \dfrac{880}{2596000} = 3.39 \times 10^{-4}$ kg [1]

(c) (i) (1) $R = \dfrac{V^2}{P}$ [1]

$= \dfrac{(220)^2}{1100} = 44\ \Omega$ [1]

(2) $R = \dfrac{(110)^2}{1100} = 11\ \Omega$ [1]

(ii) (1)



< In 220 V mode, the two resistors are in series > [1]

< In 110 V mode, the two resistors are in parallel > [1]

< All the connections are correct > [1]

(2) Resistance of each wire $= 22\ \Omega$ [1]

(iii) The iron cannot function properly. [1]

When the iron is in 220 V mode, its resistance is 44 Ω.

Thus the power output $= \dfrac{(110)^2}{44} = 275$ W [1]

This power is much smaller than the rated value. [1]

11. (a) The water can be heated uniformly by convection. [1]

(b) (i) $E = m c \Delta T$ [1]

$= (24.1)(4200)(65 - 15) = 5.06 \times 10^6$ J [1]

11. (b) (ii) $E = P t$ [1]

$(5.06 \times 10^6) = P(24.3 \times 60)$ $\therefore P = 3470$ W

$P = V I$ [1]

$(3470) = (220) I$ $\therefore I = 15.8$ A [1]

(c) Thick wires has smaller resistance, [1]

thus reduce the heating effect of current on the wires. [1]

OR

Thin wires are not used since their resistance is greater [1]

and thus the wires may be over-heated. [1]

12. (a) Both light bulbs can work under rated voltage. [1]

When one light bulb burns out, the other light bulb can still work. [1]

(b) When the switch is off, the light bulb is cut off from high voltage. [1]

Thus no electric shock occurs when the light bulb is touched. [1]

(c) Total cost of filament light bulb $= 5 + 4000 \times \dfrac{40}{1000} \times 0.95 = \$\ 157$ [1]

Total cost of energy saving bulb $= 35 + 4000 \times \dfrac{8}{1000} \times 0.95 = \$\ 65.4$ [1]

Total money saved $= 157 - 65.4 = \$\ 91.6$ [1]

13. (a) Equivalent resistance : $R = \dfrac{50 \times 50}{50 + 50} = 25\ \Omega$ [1]

$P = \dfrac{V^2}{R}$ [1]

$= \dfrac{220^2}{25} = 1936$ W < accept 1940 W > [1]

(b) [1]

Power output settings	Circuit
Low	Z
Medium	X
High	Y

(c) Any **ONE** of the following : [1]

* The hair dryer has a plastic case.
* The case of the hair dryer is an insulator.
* The hair dryer has double insulation.

14. (a) $P = \frac{E}{t} = \frac{(2526-126)}{2\times60}$ [1]

$= 20\ \text{W}$ [1]

(b) By $P = VI$

$\therefore\ (20) = (12)\,I$ [1]

$\therefore\ I = 1.67\ \text{A}$ [1]

(c) Total current $= 1.67 \times 2 = 3.34\ \text{A}$ [1]

As the total current is less than 5 A, the fuse will not blow. [1]

15. (a) keeping warm [1]

(b) By $P = \frac{V^2}{R}$

$\therefore\ (88) = \frac{(220)^2}{R_1}$ [1]

$R_1 = 550\ \Omega$ [1]

(c) Power given out by the resistor $R_2 = 550 - 88 = 462\ \text{W}$ [1]

By $P = VI$

$\therefore\ (462) = (220)\,I_2$ [1]

$\therefore\ I_2 = 2.1\ \text{A}$ [1]

16. (a) $R = \frac{(220)^2}{(500)} = 96.8\ \Omega$ [1]

(b) $P = \frac{V^2}{R_{eq}} = \frac{(220)^2}{(96.8+96.8)}$ [1]

$= 250\ \text{W}$ [1]

OR

$P_1 = P_2 = \frac{V^2}{R} = \frac{(110)^2}{(96.8)} = 125\ \text{W}$ [1]

Total power $= 125 \times 2 = 250\ \text{W}$ [1]

OR

$I = \frac{V}{R_{eq}} = \frac{(220)}{(96.8+96.8)} = 1.136\ \text{A}$

$P = I^2 R_{eq} = (1.136)^2 \times (96.8 \times 2) = 250\ \text{W}$ [1]

16. (c) Mode Z has the largest power dissipation, [1]

since the equivalent resistance of mode Z is the smallest. [1]

(d) (i) Mode Z draws the largest current. [1]

$I = \frac{220}{96.8} \times 2 = 4.55\ \text{A}$ [1]

OR

$I = \frac{500}{220} \times 2 = 4.55\ \text{A}$ [1]

The 5 A fuse would be the most suitable one. [1]

(ii) The claim is not correct. The switch must be installed in the wire A which is the live wire [1]

so that the heater is cut off from high voltage when the switch is off. [1]

(iii) Wire C is the Earth wire that could prevent an electric shock [1]

since current would be conducted from the case through this wire to the Earth. [1]

17. (a) (i) To X [1]

(ii) $P = VI \quad \therefore\ (800) = (220)\,I$ [1]

$\therefore\ I = 3.64\ \text{A}$ [1]

(iii) By $P = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$

$\therefore\ (800) = \frac{5\,(220)^2}{4R}$ [1]

$\therefore\ R = 75.625\ \Omega$

To keep warm :

$P = \frac{V^2}{4R} = \frac{(220)^2}{4\,(75.625)}$ [1]

$= 160\ \text{W}$ [1]

OR

$(800) = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$ [1]

$P_{warm} = \frac{V^2}{4R}$ [1]

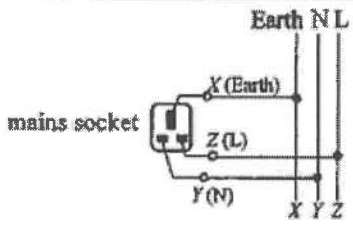
$= (800) \times \frac{1}{5} = 160\ \text{W}$ [1]

(b) (i) electrical energy [1]

(ii) (1) only the fuse blows [1]

(2) only the RCCB cuts off the supply [1]

18. (a)



1A

1

(b) (i) - If one of the lighting sets / circuits fails, the other (in parallel) can still operate, i.e. both work independently.
- Both can work at the rated power.
- Any reasonable answer

Any ONE

1A

1

(ii) $P = IV$

$(300 + 450) = I(220)$

$I = \frac{P_1}{V} + \frac{P_2}{V} = \frac{300}{220} + \frac{450}{220}$

$I = 3.409091\ \text{A} \approx 3.41\ \text{A}$

1M
1A

Thus 5 A fuse should be used.

1A

3

(c) Electrical energy used per day
$= 0.500\ \text{kW} \times 8\ \text{h} + 2\ \text{kW} \times 0.5\ \text{h} + 3\ \text{kW} \times 2\ \text{h}$
$= 11\ \text{kW h}$

1M

Cost $= \$0.9 / \text{kW h} \times 11\ \text{kW h}$
$\approx \$9.9$

1M
1A

3