

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 (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 A : M.C.

PA - HG2 - M / 01

HG2 : Transfer Processes

Part A : HKCE examination questions

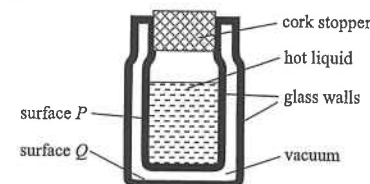
1. < HKCE 2005 Paper II - 7 >

The photograph shows a hot potato wrapped by shiny aluminium foil. By what means can the foil help reducing the rate of energy lost from the potato to the surroundings?

- (1) conduction
 - (2) convection
 - (3) radiation
- A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only



2. < HKCE 2006 Paper II - 9 >

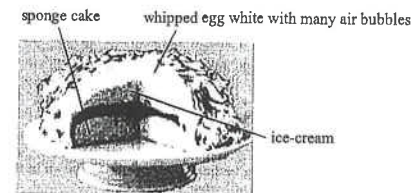


The figure shows a vacuum flask with two glass walls. Which of the following statements are correct?

- (1) The surfaces *P* and *Q* are painted silvery to reduce heat loss.
 - (2) The cork stopper reduces heat loss by conduction and convection.
 - (3) The vacuum between the double glass walls reduces heat loss by radiation.
- A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

3. < HKCE 2007 Paper II - 9 >

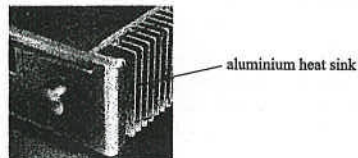
The diagram below shows the structure of a cake.



The ice-cream inside the cake does not melt when it is baked in an oven. Which of the following statements are possible reasons for this phenomenon?

- (1) The whipped egg white is a poor conductor of heat.
 - (2) The whipped egg white is a good radiator of heat.
 - (3) The sponge cake is a poor conductor of heat.
- A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

4. < HKCE 2008 Paper II - 9 >



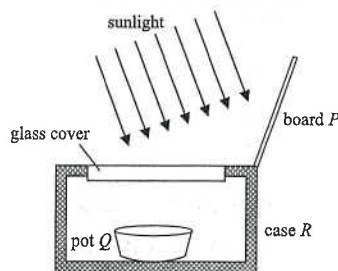
The above figure shows the aluminium heat sink of an audio amplifier which is used to transfer heat away from the components inside the amplifier. Which of the following statements about the heat sink is/are correct ?

- (1) The heat sink is made of aluminium so that it can transfer heat away faster by conduction.
- (2) The heat sink is silver in colour so that it can transfer heat away faster by radiation.
- (3) The heat sink has a fin-like design to increase the surface area so that it can transfer heat away faster by conduction to air.

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

5. < HKCE 2011 Paper II - 12 >

The figure below shows a solar cooker. Which of the following statements about its design is incorrect ?

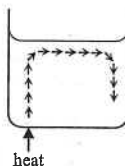


- A. Board *P* should be shiny to reflect sunlight into the cooker.
- B. Pot *Q* should be painted in black to increase the heat absorption.
- C. Case *R* should be made of metal to enhance heat transfer.
- D. The glass cover can reduce heat loss by convection.

Part B : Supplemental exercise

6. The diagram shows an experiment that demonstrates convection taking place in water. What happens to the water to cause the convection ?

- A. The water expands and its density decreases.
- B. The water expands and its density increases.
- C. The water contracts and its density decreases.
- D. The water contracts and its density increases.



7. A metal spoon is put into a bowl of hot soup. When it is taken out of the soup, it cools by emitting

- A. electrons.
- B. infra-red radiation.
- C. visible light.
- D. ultra-violet radiation.

8. In winter, when we sit on a metal chair, we feel cold continuously. What is the reason behind ?

- A. Metal has a small specific heat capacity.
- B. Metal is a good reflector of heat.
- C. Metal is a good radiator of heat.
- D. Metal is a good conductor of heat.

9. Which of the followings are related to the process of convection ?

- (1) Some birds use hot air currents to gain height.
- (2) At day time, breezes move from sea to land.
- (3) At night time, breezes move from land to sea.

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

10. Which of the following processes does not involve the movement of molecules ?

- A. conduction
- B. convection
- C. radiation
- D. diffusion

11. Which of the following animals is the best emitter of infra-red radiation from their bodies ?

- A. a white cat
- B. a black dog
- C. a brown horse
- D. a red fox

12. Arrange the following materials from the poorest conductor to the best conductor in order.

- (1) air
- (2) copper
- (3) vacuum
- (4) water

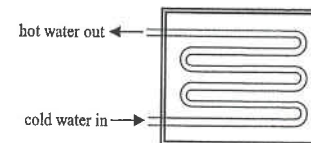
- A. (1), (3), (2), (4)
- B. (1), (3), (4), (2)
- C. (3), (1), (2), (4)
- D. (3), (1), (4), (2)

13. The radiators on motor cars are painted black. What is the reason behind ?

- A. It will not get dirty easily.
- B. Black surface is a good emitter of heat.
- C. Black surface is a good conductor of heat.
- D. Black surface is more beautiful.

14. Which of the following is NOT an application of the poor conductor of heat ?
- wooden handles of frying pans
 - fur of the animals
 - cooling fins of the engine radiators
 - double glazing of windows
15. Which of the following correctly describes shiny surfaces concerning infra-red radiation ?
- They are good absorbers and good emitters.
 - They are good absorbers but poor emitters.
 - They are poor absorbers and poor emitters.
 - They are poor absorbers but good emitters.
16. A metal rod and a rubber rod are at the same temperature. When they are held in the hand, the metal rod "feels" colder than the rubber rod. The best explanation for this observation should be
- metal has a higher melting point than rubber.
 - metal has a lower specific heat capacity than rubber.
 - metal is a better conductor of heat than rubber.
 - metal is a better absorber of heat than rubber.
17. Which of the following correctly describes dull surfaces concerning infra-red radiation ?
- They are good absorbers and good emitters.
 - They are good absorbers but poor emitters.
 - They are poor absorbers and poor emitters.
 - They are poor absorbers but good emitters.
18. A bowl of hot soup is placed in air. Which of the following transfer processes would carry away the energy from the soup to cool it down ?
- conduction
 - convection
 - radiation
- (1) & (2) only
 - (1) & (3) only
 - (2) & (3) only
 - (1), (2) & (3)
19. Which of the following substances is the best conductor of heat ?
- vacuum
 - air
 - water
 - iron
20. Which of the following process can heat be transferred in a vacuum ?
- conduction
 - convection
 - radiation
- (1) only
 - (2) only
 - (3) only
 - (2) & (3) only

21.



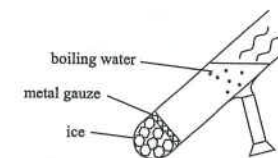
The above figure shows a simple solar heater. What type of material should be used for the pipe to give the hottest water from the heater ?

- Plastic painted white
 - Plastic painted black
 - Copper painted white
 - Copper painted black
22. Normally, the conduction of heat through a substance depends on its state. Which of the following correctly arranges the three states from the poorest conductor to the best conductor ?
- | | | |
|-----------|--------|--------|
| A. gas | liquid | solid |
| B. solid | gas | liquid |
| C. gas | solid | liquid |
| D. liquid | gas | solid |
23. When a match is placed near the flame of a Bunsen burner as shown, it is found that the match does not ignite. Which of the following is the best reason ?
- The temperature of the flame is not high enough.
 - Air is not a good conductor of heat.
 - There is no convection current near the flame.
 - There is no radiation from the flame.



24. In a hot summer day, Peter wears white shirt and black trousers. When he stands under the sun, he feels that his feet are hotter than his back. Which of the following is the possible reason ?
- The white shirt emits less infra-red radiation than the black trousers.
 - The white shirt emits more infra-red radiation than the black trousers.
 - The white shirt absorbs less infra-red radiation than the black trousers.
 - The white shirt absorbs more infra-red radiation than the black trousers.

25. In the diagram shown, a piece of metal gauze is used to keep the ice at the bottom of the test tube. The upper part of the test tube is then heated until the water boils. However, the ice still exists at the bottom. Which of the followings are the possible reasons ?



- Water is not a good conductor of heat.
- Convection can hardly be set up between boiling water and ice.
- The metal gauze prevents heat from conducting to the ice.

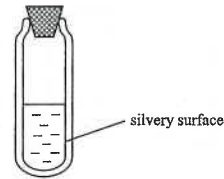
- (1) & (2) only
- (1) & (3) only
- (2) & (3) only
- (1), (2) & (3)

26. A vacuum can prevent heat transfer by

- conduction
- convection
- radiation

- (1) only
- (2) only
- (3) only
- (1) & (2) only

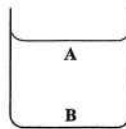
27.



In a vacuum flask, the inside walls have silvery surface. The main purpose of this design is to reduce heat transfer by

- A. conduction only.
- B. radiation only.
- C. conduction and convection only.
- D. convection and radiation only.

28.

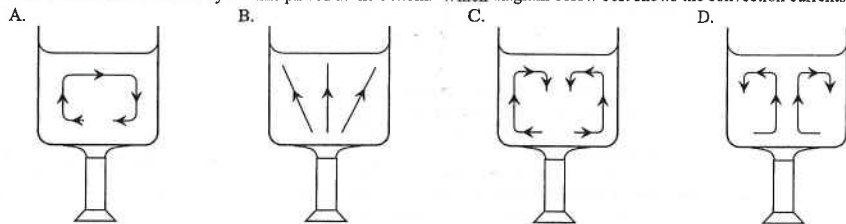


Billy wants to set up a convection current inside the water in a metal tank. Which of the following methods can achieve this?

- (1) Heat the water at A.
- (2) Cool the water at A.
- (3) Cool the water at B.

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

29. A beaker of water is heated by a flame placed at the bottom. Which diagram below best shows the convection currents?

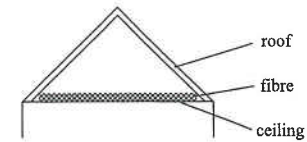


30. In a water heating system, the hot water from the heater flows to the tap through water pipes. However, heat is lost during the flowing process. Which of the following statements are correct concerning the flowing process?

- (1) Heat is lost through the walls of the pipes by conduction.
- (2) Heat is lost through the surrounding air by convection.
- (3) Heat is lost to the surrounding by radiation.

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

Questions 31 and 32 : The following figure shows the design of the top of a house.



31. What material should be used to cover the roof of the house in order to keep the house cooler in a hot day under the Sun?

- A. a layer of red brick
- B. a layer of dark soil
- C. a layer of black paint
- D. a layer of white paint

32. Fibre is used to separate the roof and the ceiling. How may fibre help to prevent heat from passing through the ceiling?

- A. Fibre allows air to pass through easily.
- B. Fibre traps air.
- C. Fibre is cold.
- D. Fibre is light in colour.

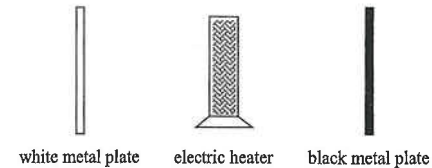
33. Which of the following correctly explains the main reason for the heat to be transferred in the process of convection?

- A. The heat is carried away by infra-red radiation.
- B. The process is achieved due to the temperature difference in a solid.
- C. The process is achieved due to the density difference in a fluid.
- D. The process is achieved due to the vibration of molecules.

34. In the design of a solar heater, the panels are painted black in colour. What is the reason behind?

- A. To make the panel become good conductor.
- B. To allow convection to take place.
- C. To improve the absorption of infra-red radiation.
- D. To improve the emission of infra-red radiation.

35.



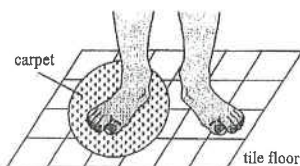
Two identical metal plates, one painted with white colour and the other painted with black colour, are placed at equal distances from a radiant heater as shown. After some time, which metal plate absorbs more energy and which metal plate emits more energy?

Metal plate that absorbs more energy **Metal plate that emits more energy**

- | | | |
|----|-------|-------|
| A. | white | white |
| B. | white | black |
| C. | black | white |
| D. | black | black |

Part C : HKDSE examination questions

36. < HKDSE Sample Paper IA - 1 >



Cynthia places a carpet on a tile floor. After a while, she stands in bare feet with one foot on the tile floor and the other on the carpet as shown. She feels that the tile floor is colder than the carpet. Which of the following best explains this phenomenon ?

- A. The tile is a better insulator of heat than the carpet.
- B. The tile is at a lower temperature than the carpet.
- C. The specific heat capacity of the tile is smaller than that of the carpet.
- D. Energy transfers from Cynthia's foot to the tile at a greater rate than that to the carpet.

37. < HKDSE 2014 Paper IA - 1 >



Two identical scoops of ice-cream are transferred from a refrigerator into paper cup *X* and vacuum flask *Y* shown above. Under room temperature, the time required for the ice-cream in the containers to melt completely is t_X and t_Y respectively. What is the expected result and explanation ?

- A. $t_X > t_Y$ as the vacuum flask reduces heat loss to the surroundings.
- B. $t_X > t_Y$ as the vacuum flask retains the heat.
- C. $t_Y > t_X$ as the vacuum flask keeps things cold by releasing heat into the surroundings.
- D. $t_Y > t_X$ as the vacuum flask reduces the rate of heat gain from the surroundings.

38. < HKDSE 2015 Paper IA - 1 >

A driver parks his car outdoor under the sun. After parking, he switches off the engine of the car. Two hours later when he gets back into the car, he feels that the inside of the car is far hotter than outside.

The best explanation is

- A. the car's engine is still generating heat after the engine has been switched off.
- B. the car's metal parts absorb infra-red radiation at a faster rate than the surroundings.
- C. the glass windows of the car trap infra-red radiation and a greenhouse effect results.
- D. the surrounding air is a good insulator of heat which reduces heat loss by conduction.

39. < HKDSE 2016 Paper IA - 1 >

Some icy cold liquid is kept cold inside a vacuum flask. Which statements are correct ?

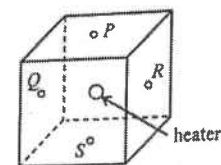
- (1) The flask's cork stopper reduces heat gain from the surroundings.
- (2) The silver coating on the inner surface of the glass wall is a good reflector of infra-red.
- (3) The vacuum between the double glass walls reduces heat gain by radiation.

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

40. < HKDSE 2019 Paper IA-1 >

41. < HKDSE 2020 Paper IA-1 >

A heater is installed at the centre of a fully filled cubic water tank. Temperature sensors *P*, *Q*, *R* and *S* are fixed at the respective centres of the top, left, right and bottom surfaces of the tank.



After the heater is switched on for a short duration, which pair of sensors below would indicate the largest temperature difference ?

- A. *Q* and *R*
- B. *R* and *S*
- C. *Q* and *S*
- D. *P* and *R*

HKBA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

M.C. Answers

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

M.C. Solution

1. B
- * (1) Aluminium is a good conductor ;
heat lost by conduction cannot be reduced.
To reduce heat lost by conduction, the potato should be wrapped with an insulated foil.
 - * (2) Convection outside the wrapped potato can still take place after wrapping with aluminium foil.
To reduce heat lost by convection, the potato should be placed inside an insulated box.
 - ✓ (3) Shiny surface of the aluminium foil is poor emitter of radiation,
thus heat lost is reduced.
2. A
- ✓ (1) Silvery can reduce heat loss by radiation since silvery surface is a poor emitter of radiation.
 - ✓ (2) Cork is a poor conductor and reduces heat loss by conduction.
The stopper prevents hot air rises up and reduces heat loss by convection.
 - * (3) Vacuum can reduce heat loss by conduction and convection but not radiation,
as heat radiation can transfer through vacuum.
3. B
- ✓ (1) Since the whipped egg white is a poor conductor, heat can hardly transfer from the top to the ice-cream.
 - * (2) The egg white is white in colour, it should be a poor radiator, and radiation is not a factor here.
 - ✓ (3) Since the cake is a poor conductor, heat can hardly transfer from the bottom to the ice-cream.

4. D
- ✓ (1) Aluminium is a good conductor, it can conduct heat away faster.
 - * (2) Silver in colour transfers heat away by radiation slower, not faster.
 - ✓ (3) Fin-like design can increase the surface area for faster conduction of heat.
5. C
- ✓ A. Board *P* should be shiny to reflect sunlight into the cooker, so that more solar energy can enter the case.
 - ✓ B. Pot *Q* should be painted in black to increase the heat absorption, since black surface is good absorber.
 - * C. Case *R* should be made of insulator to reduce heat lost to the surroundings.
 - ✓ D. The glass cover can reduce heat loss by convection, as hot air cannot escape from the case.
6. A
- When water is heated, it expands and density decreases.
Thus it rises to the top to form the convection current.
7. B
- All hot or warm objects would emit heat by radiation which is infra-red radiation.
8. D
- Since metal is a good conductor of heat, it conducts heat continuously from our body to make us feel cold.
9. D
- ✓ (1) Some birds make use of the rise of hot air currents to gain height and reach the upper sky.
The air currents are due to convection in air.
 - ✓ (2) At day time, the land is hotter than the sea.
Air above the land rises and breezes move from the sea to the land to form convection current.
 - ✓ (3) At night time, the sea is hotter than the land.
Air above the sea rises and breezes move from the land to the sea to form convection current.
10. C
- Radiation is the transfer of energy by infra-red radiation which can travel in vacuum,
thus it does not involve any molecular motion.
11. B
- Black colour surface is the best emitter of radiation.
12. D
- Vacuum does not conduct heat, therefore it is the poorest.
Air is a gas which is poor conductor.
Water is a liquid which does not conduct heat well, but the conduction is better than air.
Copper is a solid which is the best conductor.

13. B
Black surface is a good emitter of radiation, thus heat can be emitted quickly.
14. C
- ✓ A. Wood is a poor conductor.
It is used so that heat cannot conduct well to the handles from the hot pans.
 - ✓ B. The fur of the animals traps air and is poor conductor of heat.
They prevent heat lost from the bodies of animals to the surrounding air.
 - * C. Cooling fins of the engine radiators are made of good conductors to conduct away heat quickly.
 - ✓ D. Double glazing window contains air between two sheets of glass.
It can reduce heat flow across the window by conduction.
15. C
Shiny surfaces are both poor absorber and poor emitter of infra-red radiation.
16. C
Since metal is a better conductor of heat, it conducts heat quickly away from the hand, thus the hand feels cold.
17. A
Dull surfaces are both good absorber and good emitter of infra-red radiation.
18. D
- ✓ (1) Heat is conducted away from the bowl to the surrounding air.
 - ✓ (2) Above the soup, convection currents form to carry away the energy from the soup.
 - ✓ (3) The soup emits infra-red radiation to lose energy.
19. D
Iron is metal, all metals are good conductors, thus iron is the best conductor of heat among the given substances.
20. C
- * (1) Conduction requires a medium (solid, liquid or gas) to transfer heat.
 - * (2) Convection requires a fluid (liquid or gas) to form a convection current.
 - ✓ (3) Radiation transfer heat by infra-red radiation which can travel through vacuum.
21. D
Copper is a good conductor.
It should be used so that heat can conduct well from the pipe into the water.
Black surface is a good absorber of radiation.
The surface should be painted black to absorb more heat by radiation.

22. A
Gas is the poorest conductor
Solid is the best conductor among the three states of substances.
23. B
Since air is not a good conductor, heat cannot be conducted well to the match.
Thus the temperature of the match is not high enough to be ignited.
24. C
Since the white shirt is a poor absorber of radiation,
it absorbs less heat than the black trousers which is a good absorber of radiation.
25. A
- ✓ (1) As water is not a good conductor of heat, heat is not easy to conduct from the top to bottom of tube.
 - ✓ (2) Since the hot water is at the top and ice at bottom, convection current can hardly be set up between them.
 - * (3) Metal gauze is a good conductor. It does not prevent heat to be conducted.
26. D
- ✓ (1) Conduction requires a medium to transfer heat. Thus, there is no conduction in vacuum.
 - ✓ (2) Convection requires a fluid to transfer heat. Thus, there is no convection in vacuum.
 - * (3) Radiation can take place in vacuum.
27. B
Silvery surfaces are poor emitter of radiation.
28. B
- * (1) If the water at *A* is heated, the hot water has no place to rise to form convection currents.
 - ✓ (2) If the water at *A* is cooled, the cold water sinks to form convection currents.
 - * (3) If the water at *B* is cooled, the cold water has no place to sink to form convection currents.
29. D
The hot water rises to the top and then flows to the sides of the beaker to form convection currents.
30. D
- ✓ (1) Some heat is lost by conduction through the walls of the pipes.
 - ✓ (2) Since the temperature of the pipe should be higher than the room temperature, air around the pipe is heated and rises to form convection currents.
 - ✓ (3) All warm objects would emit heat by radiation.

31. D
White colour surfaces are poor absorbers of radiation.
32. B
Fibre traps air to become a poor conductor of heat.
33. C
For convection current to be formed, the fluid must have different densities at different temperatures so that hot fluid rises and cold fluid sinks.
34. C
The panels of a solar heater is painted black since black surface is good absorber, it can absorb more heat by radiation.
35. D
Black surfaces are both good absorber and good emitter of radiation.
36. D
- * A. The tile is a better conductor of heat than the carpet, not better insulator.
 - * B. Both the tile and the carpet are at the same temperature of the surroundings.
 - * C. For a fixed amount of energy transfer and same mass, smaller value of specific heat capacity would cause greater rise of temperature. But in this case, the energy is transferred from the foot continuously with different rate.
 - ✓ D. Since the tile is a better conductor than the carpet, heat is transferred from the foot to the tile at a greater rate than that to the carpet ; thus the tile floor is felt colder.
37. D
The vacuum flask Y takes longer time for the ice-cream to melt completely since the vacuum flask can reduce the heat transfer with the surroundings, thus reduce the rate of heat gain from the surroundings.
38. C
- * A. The car's engine would stop giving out heat when the engine has been cooled down after some time when the engine has been switched off.
 - * B. The car's metal parts absorb infra-red radiation would only cause the metal body of the car hot, but not the temperature inside the car.
 - ✓ C. Infra-red radiation from the Sun can pass through the window to heat up the air inside the car, but the infra-red radiation inside the car cannot pass through the window and is trapped inside. This is the greenhouse effect.
 - * D. Heat is trapped inside the car by greenhouse effect. Heat loss by conduction is not the main reason.

39. A
- ✓ (1) The cork stopper is a poor conductor, it can reduce heat gain from the surrounding air by conduction. The stopper can reduce heat gain from the surroundings by convection.
 - ✓ (2) The silver coating is a good reflector of infra-red and thus reduce heat gain by radiation.
 - * (3) Vacuum cannot reduce heat gain by radiation, it can only reduce heat gain by conduction and convection.

The following list of formulae may be found useful :

Energy transfer during heating or cooling $E = m c \Delta T$

Part A : HKCE examination questions

1. < HKCE 2007 Paper I - 3 >

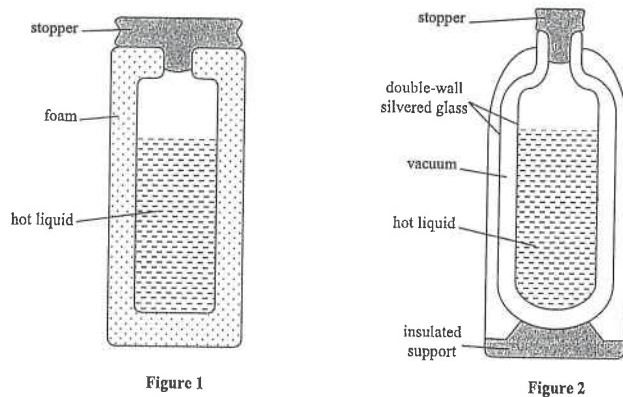
Read the following passage about thermal flasks and answer the questions that follow.

Working principles of thermal flasks

Thermal flasks are used to store hot liquids and can keep them warm for a period of time. Insulating by foam and insulating by vacuum are two common ways of making thermal flasks.

For a thermal flask applying insulation by foam, a layer of foam is used to wrap the container (see Figure 1). Both the foam and the air trapped inside the foam are poor conductors of heat. Also, the air inside the foam is broken into many tiny bubbles, which reduce convection of air inside the foam. Heat transfer through foam is therefore pretty slow.

For a thermal flask applying insulation by vacuum, there is a vacuum between the double glass walls of the container (see Figure 2). The heat insulation of vacuum is better than that of foam. Furthermore, the inner surface of walls of the glass container is painted silvery to reduce heat transfer. As glass is fragile, the glass container is protected by an outer case with an insulated support.



(a) Explain how the foam reduces heat transfer by conduction and convection. (2 marks)

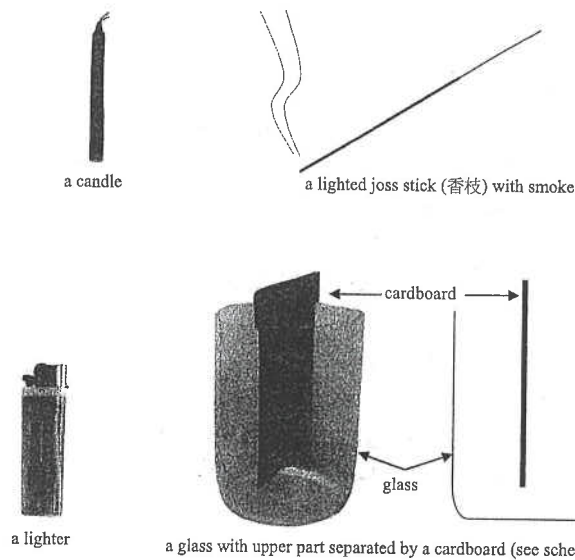
(b) Explain why the heat insulation of vacuum between the double glass walls is better than that of foam. (2 marks)

1. (c) State ONE design in the vacuum flask shown in Figure 2 that helps to reduce heat loss by radiation. (1 mark)

(d) Can a thermal flask also store cold liquids and keep them cold for a period of time? Explain your answer. (2 marks)

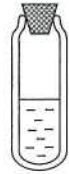
2. < HKCE 2010 Paper I - 3 >

Describe how to use the apparatus as shown in the Figure below to conduct an experiment to demonstrate the convection of air current. (4 marks)



Part B : Supplemental exercise

3.



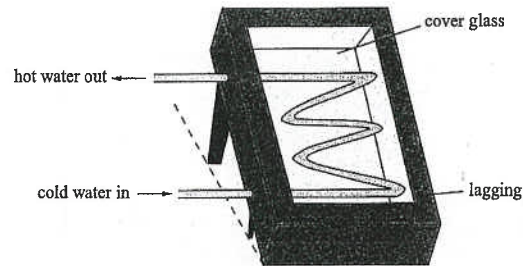
The above figure shows a vacuum flask used for keeping hot liquids warm.

(a) What is the use of the stopper placed at the top of the flask ? (2 marks)

(b) Why do the inside walls of the flask have silvery surfaces ? (2 marks)

(c) Why is the space between the inner wall and outer wall vacuum ? (2 marks)

4.



The figure above shows a simple solar heater.

(a) (i) Why should the inner wall of the heater and surface of the pipe be blackened ? (2 marks)

(ii) The heater is covered by a sheet of glass. Give one reason for this. (1 mark)

(iii) Suggest one material suitable for the lagging. (1 mark)

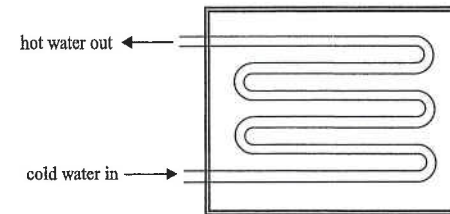
4. (b) When water flows through the pipe in the solar heater at a rate of 0.01 kg s^{-1} , its temperature rises by 7°C .

(Specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$.)

(i) Find the power supplied by the heater. (3 marks)

(ii) If the rate of flow of water were reduced to 0.04 kg min^{-1} , find the increase in temperature. Briefly comment on your answer. (4 marks)

5.



The above figure shows a solar panel used to heat water.

(a) State the process by which energy is transferred

(i) from the sun to the outside of the pipe in the solar panel ; (1 mark)

(ii) from the outside of the pipe to the water inside it. (1 mark)

(b) The following is a list of materials which are proposed to be used as the pipe material that contains the water.

“polished copper, glass, white plastic, black plastic, black-painted copper”

Suggest the most suitable material for the pipe. Give two reasons to support your choice. (3 marks)

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

Question Solution

1. (a) Foam is a poor conductor of heat. [1]
 The small air bubbles inside the foam reduce the air convection. [1]
- (b) Vacuum does not have air, thus no conduction of heat. [1]
 Vacuum does not have air, thus no air convection. [1]
- (c) The vacuum flask has silvery surface to reduce radiation. [1]
- (d) Yes ! [1]
 Since the thermal flask can reduce heat transfer, the liquid can be kept cold for a period of time. [1]
2. Put the candle in the glass and light up the candle with the lighter. [1]
 Put the lighted joss stick inside the other side of the glass. [1]
 Observe the movement of the smoke. [1]
 The smoke from the joss stick moves through the bottom of the separator and rises on the side of the candle. [1]
3. (a) To reduce heat lost by convection and conduction. [1]
 [1]
- (b) To reduce heat lost by radiation. [1]
 since silvery surface is a poor emitter of radiation. [1]
- (c) To reduce heat lost by conduction and convection. [1]
 [1]
4. (a) (i) To ensure maximum amount of heat absorbed [1]
 since blackened surface is a good absorber of infra-red radiation. [1]
- (ii) To prevent cooling by convection. [1]
OR
 To trap heat by greenhouse effect. [1]
- (iii) Any **ONE** of the followings : < **OR** any other suitable insulator > [1]
 * cotton wool
 * foam
 * polystyrene
- (b) (i) By $Pt = mc\Delta T$ [1]
 $\therefore P(1) = (0.01) \times (4200) \times (7)$ [1]
 $\therefore P = 294 \text{ W}$ [1]

4. (b) (ii) In 1 minute, heat supplied by the heater = $Pt = (294)(1 \times 60) = 17640 \text{ J}$ [1]
 By $E = mc\Delta T$
 $\therefore (17640) = (0.04)(4200)\Delta T$ [1]
 $\therefore \Delta T = 105^\circ\text{C}$ [1]
 This is impossible because water would boil at 100°C . [1]
5. (a) (i) radiation [1]
 (ii) conduction [1]
- (b) The most suitable material is black-painted copper. [1]
 Black surface is a good absorber of radiation, thus more solar energy can be absorbed. [1]
 Copper is a good conductor, thus heat can be conducted well from the pipe to the water. [1]