REFUGEE SHELTER DESIGN WORKSHOP TEST

Answer **ALL** questions

Questions **do not** carry equal marks

Maximum marks 40

Use the supplied Multiple Choice sheet for providing your answers.
Only use a HB pencil to strike out the letter you think is correct.
If you make a mistake use an eraser.
Please do not use ticks, crosses or circles.

USE A SEPARATE PAPER FOR WORKING OUT YOUR ANSWERS, IF NEEDED.

CANDIDATES MUST NOT TURN OVER THE PAGE AND READ THE EXAMINATION PAPER UNTIL THE CHIEF INVIGILATOR GIVES PERMISSION TO DO SO

Q1 Which of the following materials (if any) are **not** used as thermal insulators in building construction? (2 marks)

(A) Rock wool.
(B) Concrete.
(C) Expanded polystyrene.
(D) Hemp.
(E) All of the above materials are used.

Q2 Fabric heat transfer is **primarily**: (2 marks)

(A) Conductive.
(B) Radiative.
(C) Convective.
(D) Evaporative.
(E) None of the above.

Q3 Heat transfer by ventilation is **primarily**: (2 marks)

(A) Conductive.
(B) Radiative.
(C) Convective.
(D) Evaporative.
(E) None of the above.

Q4 The U-value is defined in which of the following units? (2 marks)

(A) $Wm^{-2}K^{-1}$.
(B) m^2KW^{-1}.
(C) $Wm^{-1}K^{-1}$.
(D) mKW^{-1}.
(E) None of the above.

Q5 Thermal conductivity is defined in which of the following units? (2 marks)

(A) $Wm^{-2}K^{-1}$.
(B) m^2KW^{-1}.
(C) $Wm^{-1}K^{-1}$.
(D) mKW^{-1}.
(E) None of the above.

Q6 Which of the following wall build-ups is likely to have the lowest U-value? All constructions are shown from outside (left) to inside (right). (2 marks)

(A) 230mm solid brick.
(B) 115mm brick - 50mm air gap - 115mm brick - 12mm plaster.
(C) 115mm brick - 50mm air gap - 50mm rigid wood fibre insulation - 2 coats of render.
(D) 2 coats of render - airtight membrane - 50mm rigid wood fibre insulation - 50mm airgap - 115mm brick - 12mm plaster.
(E) 115mm brick - 100mm rigid wood fibre insulation - 2 coats of render.

Q7 You design a three story residential building with the physical characteristics given in **Table Q7-1** below. Additionally the air tightness (infiltration rate) is measured at 0.8 ach and you install a ventilation system with a flow rate of 1200 m^3/h.

Table Q7-1

Element	Dimensions	U-Value [W/m^2K]
Total Windows	**8** $\times$ 1 m $\times$ 1 m	0.75
North/South Wall	5 m $\times$ 7.5 m	0.24
East/West Wall	10 m $\times$ 7.5 m	0.24
Ceiling/Roof	10 m $\times$ 5 m	0.20
Floor	10 m $\times$ 5 m	0.14

Given a 20°C temperature difference between inside and out, calculate the total heat gain rate (to 2 s.f.) and choose the answer from A-E below that is correct (if any). You may find the following equations useful: (5 marks)

$$N = \frac{\text{flow rate}}{\text{volume}} + \text{infiltration rate} \mid Q_{fabric} = \sum_i U_i A_i \Delta T \mid Q_{ventilation} = \frac{1}{3} N V \Delta T$$

(A) 1 kW
(B) 11 kW
(C) 17 kW
(D) 9 MW
(E) None of the above

Q8 Compute the U-value of the following sandwich panel roof construction. Assume internal and external surface resistances are 0.1 m^2KW^{-1} and 0.04 m^2KW^{-1} respectively. (5 marks)

Table Q8-1

Material	Thermal Conductivity λ [$Wm^{-1}K^{-1}$]	Thickness d [mm]
Corrugated top skin	45	5
EPS Core	0.04	75
Bottom skin	45	3

Now select the value from the list below that most closely matches yours:

(A) 0.496
(B) 0.500
(C) 0.684
(D) 0.648
(E) 0.469

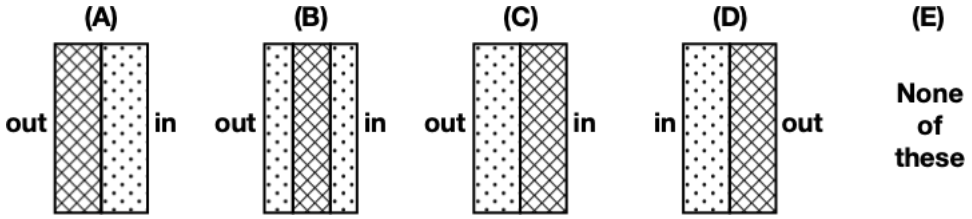
Q9 Which of the following represents heat capacity of a building element? (2 marks)

(A) $Wm^{-2}K^{-1}$
(B) $Jm^{-2}K^{-1}$
(C) $Wm^{-1}K^{-1}$
(D) $m^2K^1J^{-1}$
(E) None of the above

Q10 A heavyweight building is likely to have a thermal lag of at least: (2 marks)

(A) 1 hour
(B) 5 K
(C) 10 K
(D) 10 hours
(E) None of the above

Q11 If ▨ represents mass and ▩ represents insulation, which of the following wall configurations represents a heavyweight building? (2 marks)



Q12 For the same thickness, which of the following materials is likely to provide the greatest thermal mass in a building? (2 marks)

(A) Rammed earth
(B) Concrete
(C) Brick
(D) Wood
(E) Water

Q13 The shelter you have designed has a 50mm cavity for insulation. Which of the following products would you choose to achieve the greatest insulation effect, if each has the same cost? (2 marks)

(A) Glassfibre ($\lambda = 0.038$ $Wm^{-1}K^{-1}$)
(B) Phenolic foam ($\lambda = 0.020$ $Wm^{-1}K^{-1}$).
(C) Expanded polystyrene (EPS) ($\lambda = 0.035$ $Wm^{-1}K^{-1}$).
(D) Hemp ($\lambda = 0.040$ $Wm^{-1}K^{-1}$).
(E) Any of the above materials are suitable.

Q14 Which of the following passive design measures will **not** reduce peak internal summer temperatures in the northern hemisphere? (2 marks)

(A) Roof overhang.
(B) Large windows facing south.
(C) Wall cavities filled with gravel.
(D) Stack effect ventilation.
(E) Ventilated wall cavities.

Q15 When fitting 15mm thick EPS rolls of thermal insulation within a cavity of a shelter, which of the following will achieve the most airtight construction? (2 marks)

(A) Butt joint insulation panels.
(B) Overlap insulation by a minimum of 50mm.
(C) Leave ventilation gaps of at least 10mm between adjacent insulation panels.
(D) Ensure insulation panels have no gaps where they meet and tape all joints.
(E) Stop insulation 150mm above the floor to provide insulation.

Q16 To maximise controlled ventilation, which pattern of the following will have the best effect? (2 marks)

(A) Two windows on adjacent walls.
(B) Two windows on opposite walls.
(C) No windows.
(D) Two windows on the same wall.
(E) One window on the wall facing the prevailing wind.

Q17 You are constructing a shelter with thermal mass in the cavity. You have the option to include a 30mm layer of insulation into the wall construction. Which is the best place to position the insulation layer? (2 marks)

(A) On the external face of the thermal mass.
(B) On the internal face of the thermal mass.
(C) In the centre of the thermal mass.
(D) On both sides of the thermal mass.
(E) It is better to use no insulation.

NJM/SN