S4 Physical Education Practice Paper: Health-Related Fitness, Training Principles and Energy Systems, Sports Biomechanics, Cardiovascular and Respiratory Systems, Skill Learning and Sports Psychology, Safety and Injury Management

S4 | Physical Education | Time: 75 minutes | Total: 100 marks | 24 questions

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Part 1: Health-Related Fitness Assessment

Show your working; give BMI to one decimal place and heart rates as whole numbers.

1. A Secondary 4 student weighs 68 kg and is 1.70 m tall. Calculate his BMI to one decimal place and classify it using adult cut-offs (<18.5 underweight, 18.5-22.9 normal, 23-24.9 overweight, 25 or above obese). [4]

Answer: BMI = mass / height squared = 68 / 1.70^2 = 68 / 2.89 = 23.5, which is overweight (23-24.9). Height must be squared first; the unit is kg/m2.

2. A 16-year-old student has a resting heart rate of 62 beats per minute. Using the Karvonen formula, calculate his target heart rate at 70% intensity and show the steps. [4]

Answer: Maximum heart rate 220 - 16 = 204; heart rate reserve = 204 - 62 = 142; target = 62 + 0.7 x 142 = 161.4, i.e. about 161 beats per minute.

3. A 15-year-old student has a maximum heart rate of 205 beats per minute. Use the percentage of maximum heart rate method to find the 60% to 80% training zone. [4]

Answer: 205 x 60% = 123 and 205 x 80% = 164, so the training zone is 123-164 beats per minute.

4. The World Health Organization recommends that adolescents accumulate at least 150 minutes of moderate aerobic activity each week. If each session lasts 30 minutes, how many sessions are needed per week? Name one field test of cardiorespiratory endurance. [4]

Answer: 150 / 30 = 5 sessions; a field test of cardiorespiratory endurance is the 20 m shuttle run (beep test) or the 12-minute run, scored on completed shuttles or distance.

Part 2: Training Principles and Energy Systems

Show working for loads, repetitions and percentages, and give units in your answers.

5. An athlete has a 1RM back squat of 75 kg. He trains at 80% of 1RM for 3 sets of 8 repetitions. Find the load per set, the total number of repetitions and the total training volume (load x total repetitions). [5]

Answer: 75 x 80% = 60 kg per set; total repetitions 3 x 8 = 24; total volume 60 x 24 = 1440 kg.

6. Which energy system is the main source of ATP for a 100 m sprint and for a 30-minute jog? Give one characteristic of each system. [4]

Answer: The 100 m sprint (about 10-15 s) relies mainly on the ATP-PC (phosphocreatine) system, which is very fast but lasts only seconds; the 30-minute jog relies mainly on the aerobic system, using carbohydrate and fat with oxygen to produce large amounts of ATP slowly but sustainably.

7. Explain the principle of progressive overload and use the four FITT components to show how it is applied in a training programme. [4]

Answer: Progressive overload means gradually increasing the training stimulus so the body keeps adapting; FITT covers frequency (sessions per week), intensity (e.g. %1RM or target heart rate), time (minutes per session) and type (aerobic, resistance, flexibility), each raised as capacity improves.

8. A man weighs 60 kg and carries 12 kg of body fat. Calculate his body fat percentage and state the healthy range for men. [4]

Answer: 12 / 60 x 100% = 20%; the healthy range for men is roughly 10%-20%, and above 25% is regarded as obese.

Part 3: Sports Biomechanics

Take g = 10 m/s2; show working and give units.

9. Torque = force x moment arm. A muscle group applies 200 N at 0.25 m from the joint. Find the torque and state how a longer moment arm affects it. [5]

Answer: M = F x d = 200 x 0.25 = 50 N.m; with the same force, a longer moment arm gives a larger torque, so joint angle changes the turning effect a muscle produces.

10. Which class of lever is a heel raise (standing on tiptoe)? Identify the fulcrum, the resistance and the effort, and state whether it is a force-saving lever. [4]

Answer: It is a second-class lever: the fulcrum is at the metatarsophalangeal (toe) joint, the resistance is body weight acting through the ankle, and the effort comes from the calf muscles via the Achilles tendon; the resistance arm is shorter than the effort arm, so it is force-saving.

11. A ball is projected at 20 m/s at 45 degrees to the horizontal. Ignoring air resistance, find the horizontal range using R = v squared x sin 2(theta) / g. [4]

Answer: R = 400 x 1 / 10 = 40 m; at 45 degrees the range is greatest when air resistance is neglected.

12. A performer completes 2 full turns about the longitudinal axis in 1.0 s. Find the average angular velocity in rad/s to one decimal place. [4]

Answer: Angular displacement 2 x 2 pi = 4 pi rad, so angular velocity = 4 pi / 1.0 = 12.6 rad/s.

Part 4: Cardiovascular and Respiratory Systems

Give cardiac output and ventilation in L/min, and show your working.

13. During exercise the heart rate is 150 beats per minute and stroke volume is 100 mL. Find the cardiac output in L/min. [4]

Answer: 150 x 100 = 15 000 mL/min = 15.0 L/min.

14. A trained athlete has a maximum heart rate of 190 beats per minute and a maximum stroke volume of 120 mL; an untrained person has a maximum cardiac output of 15 L/min. Find the athlete maximum cardiac output and the percentage by which it exceeds the untrained value. [5]

Answer: 190 x 120 = 22 800 mL/min = 22.8 L/min; the increase over the untrained value is (22.8 - 15.0) / 15.0 x 100% = 52.0%.

15. At rest the breathing rate is 20 per minute with a tidal volume of 0.5 L; during vigorous exercise it is 40 per minute with a tidal volume of 2.0 L. Find the minute ventilation in each case and how many times the resting value the exercise value is. [4]

Answer: Resting 20 x 0.5 = 10 L/min; exercise 40 x 2.0 = 80 L/min; 80 / 10 = 8 times the resting value.

16. Each 100 mL of arterial blood carries about 20 mL of oxygen. How much oxygen is carried by 5 L of arterial blood (give the answer in mL and in L)? [4]

Answer: 5 000 / 100 x 20 = 1000 mL = 1 L.

Part 5: Skill Learning and Sports Psychology

Give calculated answers to one decimal place or a whole number, and use examples in short answers.

17. A student records reaction times of 0.22 s, 0.25 s and 0.28 s in three trials. Find the mean and distinguish reaction time from movement time. [4]

Answer: (0.22 + 0.25 + 0.28) / 3 = 0.25 s; reaction time runs from the stimulus to the start of the movement, while movement time runs from the start to the completion of the movement.

18. A 60-minute session is divided into 4 blocks. How long is each block, and when are massed practice and distributed practice preferred? [4]

Answer: 60 / 4 = 15 minutes per block; massed practice suits simple skills or short-term consolidation, while distributed practice with rest intervals suits complex skills and beginners because it limits fatigue and forgetting.

19. Use the SMART principle to write a specific training goal for improving standing long jump performance by 10 cm within one month. [5]

Answer: Specific: improve standing long jump distance. Measurable: add 10 cm to the current mark. Achievable: three 30-minute power and technique sessions per week. Relevant: it matches the fitness level and the examination items. Time-bound: achieve and retest within one month.

20. Explain the inverted-U hypothesis and give one sporting example in which too high a level of arousal lowers performance. [4]

Answer: The inverted-U hypothesis states that performance improves as arousal rises to a moderate optimum and then declines; in archery or golf putting, excessive tension stiffens the action and reduces accuracy.

Part 6: Safety and Injury Management

Be specific, and write first-aid procedures in the correct order.

21. Write the four steps of RICE for an acute soft-tissue injury and state how long each icing period should last. [4]

Answer: R = rest, I = ice (15-20 minutes at a time, every 2-3 hours), C = compression bandage, E = elevation; the acute phase is normally the first 24-48 hours after injury.

22. In a 60-minute session the warm-up takes 10 minutes. What percentage of the session is that, to one decimal place? State two purposes of a warm-up. [4]

Answer: 10 / 60 x 100% = 16.7%; a warm-up raises body and muscle temperature, increases joint range of motion and primes the neuromuscular system, lowering injury risk.

23. Compare heat exhaustion and heat stroke in terms of body temperature, sweating and state of consciousness. [4]

Answer: Heat exhaustion: body temperature about 37-40 C, heavy sweating, cool clammy skin, conscious but tired and dizzy. Heat stroke: temperature above 40 C, hot dry skin with sweating possibly stopping, confusion or unconsciousness; it is a medical emergency requiring immediate cooling and hospital care.

24. Drink 500 mL two hours before exercise and 150 mL every 15 minutes during exercise. How much fluid is needed in total for a 90-minute match? [4]

Answer: 500 + 150 x (90 / 15) = 500 + 150 x 6 = 1400 mL, about 1.4 L.
