1) Sketch the lever system which would represent the action of the biceps muscle in flexing the arm. Show on your diagram the resistance arm of the lever.

Answer
- See figure 4.11.
- \( E \) is the effort force in the biceps muscle.
- \( L \) is the load force applied at the hand.
- The triangle is the pivot or fulcrum of the lever.
- The resistance arm is the structure (forearm) between hand (load) and elbow (fulcrum).

2) In figure 4.7 of a jumper taking off, name, sketch and label the lever system operating at knee \( B \) during this action.

Answer
- This is a class 3 lever (effort between pivot and load).
- Note that the effort (figure 4.12) is transmitted to the tibia via the patella tendon, which passes over the knee and inserts below the joint (figure 4.13).

3) In softball, what order (class) of lever is shown in the hitting action in figure 4.8?

State one disadvantage and one advantage of reducing the bat length for a beginner.

Answer
- This is a class 1 lever.
- Advantage of shortening bat length is:
  - Learning the skill involved may be easier - since the strike point is nearer the hand.
- Disadvantage of shortening the bat would be:
  - Less force can be applied as a load for a given effort, hence the strike on the ball would impart less speed to the ball.
4) Name, sketch and label the lever system which is operating at the ankle of leg C when doing the sprint set action illustrated in figure 4.9.

Answer
- See figure 4.14.
- This is a class 2 lever.
- Note that the load force is a combination of the weight of the athlete acting downwards through the tibia and fibula on the ankle joint, and the reaction to the accelerating force driving the sprinter forwards.

5) a) Figure 4.10 shows an elbow joint A of a person performing an exercise. Draw a simplified sketch to show the lever system, indicating the various forces operating.

Answer
- Figure 4.15 – this is a class 2 lever.
- Normally the triceps elbow system is a class 1 lever, but here, the pivot is at the hand as shown, which forces the system into class 2 lever shape.

b) On your diagram draw and label the effort and resistance arm.

Answer
- Resistance arm lies between pivot and weight force (the lever arm is at right angles to the force).
- Effort arm lies between point of elbow and pivot.

6) During physical activity the performer uses a combination of levers to produce movement. Explain why the length of the lever will affect performance.

Answer
- The longer the lever (usually length of limb - the resistance arm) the greater the speed at the load (end of limb).
- The longer the lever the less effort required.
- Shorter levers generate more force (compare compact small gymnasts or weight lifters with taller performers).
- Class 1 levers are used to generate speed.
- Class 2 levers are more efficient because the effort is further away from the pivot (example - the ankle joint with calf muscles).