G.C.E. O/L Grade 11 ICT · Lesson 4

4.2 2D Animation: Frames, Key Frames, Frame Rate and Tweening

Syllabus 13.2. Cartoons on TV, a moving logo at the start of a YouTube video and a Scratch game are all **animations**. In this note you will learn how animation tricks the eye, what **frames**, **key frames** and **blank key frames** are, how the **frame rate (fps)** sets the speed, how to calculate the **duration**, the difference between **frame-by-frame** animation and **tweening**, and how to **publish** an animation as a GIF, video or HTML5 file using free tools like Synfig, Pencil2D and Scratch.

1. How animation works

An **animation** is a series of still pictures shown quickly one after another. Each picture is a **frame**. Each frame is a little different from the one before. Our eyes keep an image for a moment (**persistence of vision**), so the pictures seem to **move smoothly**. A **2D** animation is drawn on a flat surface (width and height only).

> 💡 Make a **flip book**: draw a ball in a slightly different place on the corner of each page of an exercise book, then flip the pages fast. That is animation!

2. Frame rate (fps) and duration

Frame rate is the number of frames shown each second – **frames per second (fps)**. Common rates are **12 fps** (simple cartoons, GIFs), **24 fps** (films) and **30 fps** (TV and phone video). More fps = smoother movement but more drawings. **Duration (seconds) = number of frames ÷ fps**, and **frames = seconds × fps**.

Frames	Frame rate	Duration
48	12 fps	48 ÷ 12 = 4 s
120	24 fps	120 ÷ 24 = 5 s
90	30 fps	90 ÷ 30 = 3 s
36	12 fps	36 ÷ 12 = 3 s
10 × 30 = 300	30 fps	10 s
5 × 24 = 120	24 fps	5 s

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. Layers and the timeline

Animation software shows a **timeline**. Across the top are **frame numbers**; down the side are **layers**. Like layers in GIMP, each layer holds one object – a background, a character, a title – so each can move on its own. The red **playhead** shows which frame you are looking at.

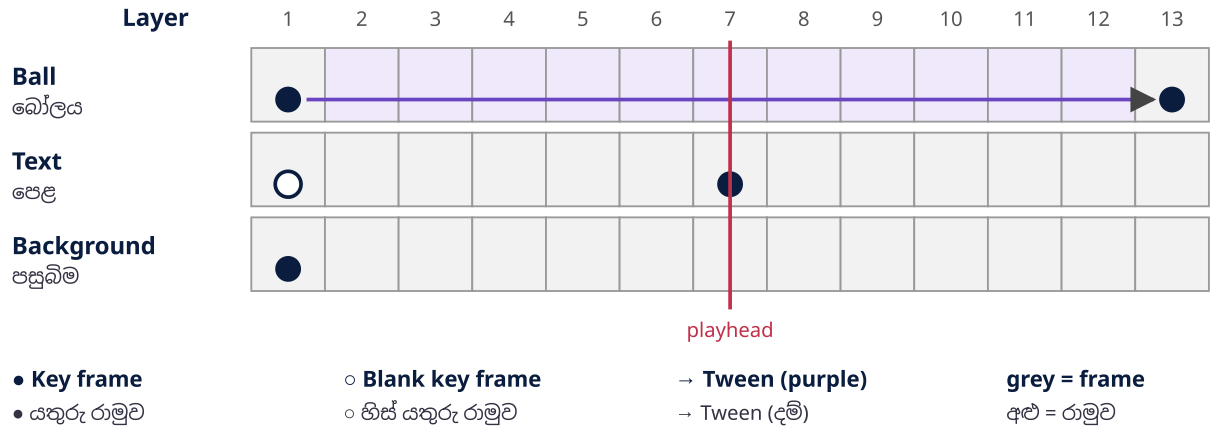


Figure 4.4 – A timeline with three layers: key frames (●), a blank key frame (○), frames (grey) and a motion tween (purple).

4. Types of frames

Frame type	Symbol	Meaning
Frame	grey cell	One picture in time; repeats the last key frame's picture
Key frame	filled circle ●	A frame where something new is drawn or changes
Initial frame	first ●	The key frame where a movement starts
Destination frame	last ●	The key frame where the movement ends
Blank key frame	empty circle ○	A key frame with nothing drawn yet

In Figure 4.4 the **Ball** layer has an **initial key frame** at frame 1 and a **destination key frame** at frame 13. The **Text** layer starts with a **blank key frame** (nothing yet) and the title appears at the key frame in frame 7. The **Background** has one key frame and then normal frames that just repeat it.

5. Geometric objects and shapes

Most 2D animations are built from simple **geometric shapes**: lines, rectangles, circles (ellipses), polygons and stars. You draw them with the shape tools, then change their **fill colour**, **stroke (outline)**, **size**, **position** and **rotation**. A sun can be a yellow circle; a house can be a square with a triangle roof.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

6. Frame-by-frame animation

In **frame-by-frame** animation you **draw every frame yourself**. It gives full control – for example a ball that **squashes** when it hits the ground – but it takes a long time. A 2-second clip at 12 fps needs 24 drawings. Pencil2D and OpenToonz are good for this.

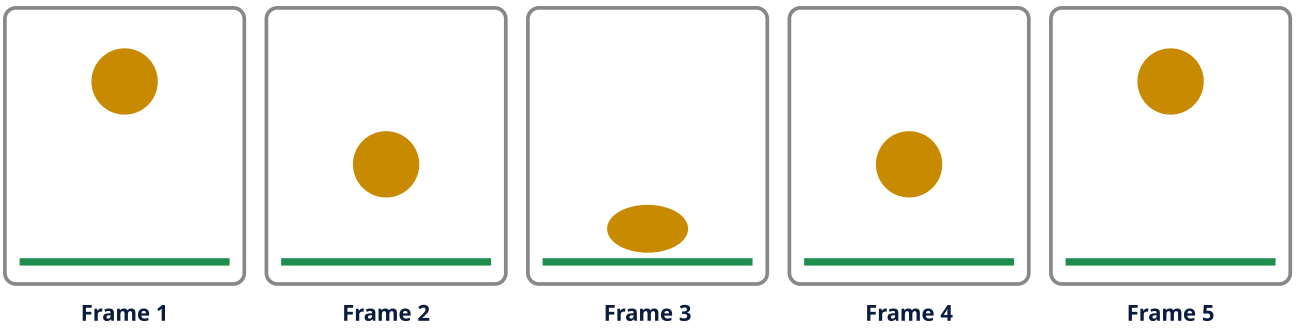


Figure 4.5 – Frame-by-frame: five hand-drawn frames of a bouncing ball.

7. Tweening – the computer draws the middle

Tweening (from “in-between”) is faster. You draw only the **initial** and **destination key frames**; the software **creates the in-between frames** automatically. With key frames at 1 and 13, the computer makes **11 in-between frames**. At 12 fps the movement lasts 13 ÷ 12 = 1.08 s.

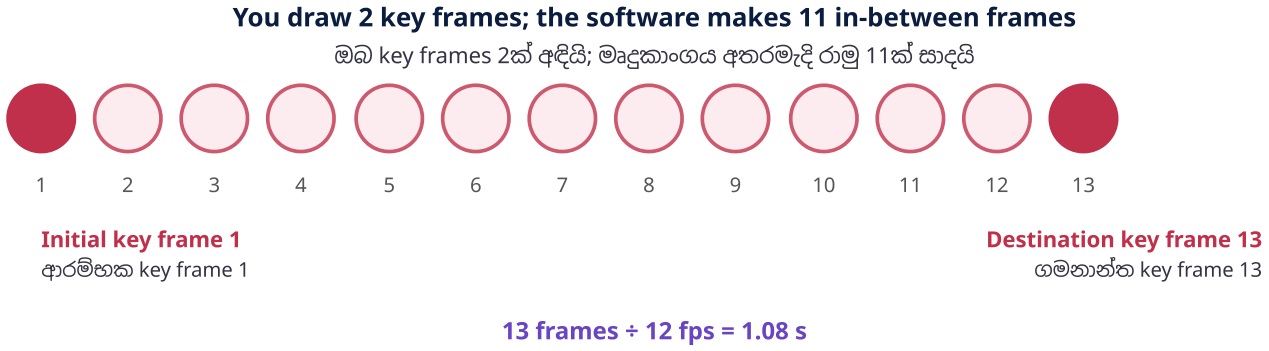


Figure 4.6 – Motion tween: the software fills in 11 frames between two key frames.

Motion tween	**Shape tween**
Motion tween	Shape tween

💡 Number of in-between frames = destination frame − initial frame − 1.

8. Publishing an animation

Output	Use
GIF	Short looping animation; no sound

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

MP4 video	Plays everywhere: YouTube, phones; with sound
HTML5 (Canvas)	Runs in a web browser; can be interactive
SWF (Flash) – old	No longer supported by browsers since 2021

Older animations were often published as **SWF** files for Adobe Flash Player. Flash ended in **2021**, so today we publish **MP4**, **GIF** or **HTML5 Canvas**.

9. Animation software

Adobe Animate
Adobe Animate

Synfig Studio
Synfig Studio

Pencil2D
Pencil2D

OpenToonz
OpenToonz

Scratch
Scratch

NEW 2026 **2026:** Canva and CapCut can add ready-made animations to text in one click, and AI tools can turn a drawing into a short moving clip. They are quick, but learning key frames and tweens lets you control **exactly** how things move – and that is what the exam tests.

Key Words

Animation – Still pictures shown quickly so they seem to move.

Frame – One single picture in an animation.

Key frame – A frame where a new drawing or change is set.

Blank key frame – A key frame with nothing drawn on it yet.

Initial frame – The key frame where a movement begins.

Destination frame – The key frame where a movement ends.

Frame rate (fps) – Number of frames shown per second.

Timeline – Shows frames across and layers down.

Frame-by-frame – Animation where every frame is drawn by hand.

Tweening – Software creates the in-between frames.

Motion tween – Tween that moves, rotates or resizes an object.

Shape tween – Tween that changes one shape into another.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Sample Q&A

1. What is a frame?

> **Answer:** One still picture in an animation.

2. What does 24 fps mean?

> **Answer:** 24 frames are shown every second.

3. How long is 120 frames at 24 fps?

> **Answer:** 120 ÷ 24 = 5 seconds.

4. What is a blank key frame?

> **Answer:** A key frame with nothing drawn yet.

5. Why is tweening faster than frame-by-frame?

> **Answer:** You draw only two key frames; the software makes the rest.

6. Name two free 2D animation programs.

> **Answer:** Synfig Studio, Pencil2D (also OpenToonz, Scratch).

MCQ

1. Animation seems to move because of

A. vector shapes
B. persistence of vision
C. high resolution
D. lossy compression

2. fps stands for

A. files per second
B. fills per shape
C. frames per scene
D. frames per second

3. How long does 48 frames at 12 fps play?

A. 4 seconds
B. 48 seconds
C. 576 seconds
D. 12 seconds

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

4. How many frames are needed for a 10-second animation at 30 fps?

A. 40
B. 300
C. 3
D. 30

5. Which frame rate is the usual standard for films?

A. 24 fps
B. 1000 fps
C. 2 fps
D. 6 fps

6. A frame where something new is drawn or changes is a

A. blank frame
B. pixel
C. key frame
D. layer

7. On a timeline a hollow circle ○ usually shows a

A. blank key frame
B. sound file
C. tween
D. key frame with a drawing

8. The key frame where a movement ends is the

A. blank frame
B. initial frame
C. first layer
D. destination frame

9. Key frames are at frame 1 and 13. How many in-between frames does the software create?

A. 13
B. 11
C. 2
D. 12

10. Drawing every frame by hand is called

A. frame-by-frame animation
B. rendering
C. motion tweening
D. shape tweening

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

11. A circle slowly changing into a star is a

A. layer mask
B. motion tween
C. shape tween
D. blank key frame

12. A bus moving from left to right across the screen is best made with a

A. blank key frame only
B. shape tween
C. motion tween
D. JPEG

13. Which format gives a short looping animation with no sound?

A. SVG
B. GIF
C. MP3
D. WAV

14. Which is a free 2D animation program?

A. Audacity
B. Inkscape
C. Microsoft Excel
D. Pencil2D

15. Old SWF animations needed

A. Audacity
B. a 3D printer
C. Adobe Flash Player
D. a scanner

Structured Questions

1. (i) What is frame rate? (1 mark)
(ii) An animation has 120 frames at 24 fps. Find its duration. (2 marks) *(3 marks)*

> (i) Number of frames shown per second (1). (ii) 120 ÷ 24 (1) = 5 seconds (1).

2. Explain key frame, blank key frame and frame. (3 marks) *(3 marks)*

> Key frame – a frame where a drawing is set or changes (1); blank key frame – a key frame with nothing drawn yet (1); frame – repeats the last key frame's content (1).

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

3. Compare frame-by-frame animation and tweening. Give one advantage of each. (4 marks) *(4 marks)*

> Frame-by-frame: every frame drawn by hand (1); full control of detail, e.g. squash (1). Tweening: only key frames drawn, software makes in-betweens (1); much faster, smooth movement (1).

4. A Grade 11 student makes a ball roll across the screen with a motion tween from frame 1 to frame 13 at 12 fps.
(i) How many in-between frames are made? (1 mark)
(ii) How long does the movement last? (1 mark) *(2 marks)*

> (i) 13 − 1 − 1 = 11 (1). (ii) 13 ÷ 12 = 1.08 s (1).

5. Name two formats to publish an animation and say where each is used. (4 marks) *(4 marks)*

> MP4 (1) – YouTube, phones, with sound (1); GIF (1) – short looping clip on a website or chat (1). (HTML5 Canvas – runs in a browser – also accepted.)

Summary

- Animation = still frames shown fast; persistence of vision.
- fps: 12 cartoons/GIF, 24 films, 30 TV/phone.
- Duration = frames ÷ fps; frames = seconds × fps.
- Timeline: frames across, layers down, playhead shows current frame.
- Key frame ●, blank key frame ○, initial and destination frames.
- Frame-by-frame = draw every frame; tweening = software makes in-betweens.
- Motion tween moves; shape tween changes shape; in-betweens = last − first − 1.
- Publish as MP4, GIF or HTML5 (SWF/Flash ended 2021).

MCQ answer key – 4.2

1. **B** – The eye holds each picture for a moment.
2. **D** – Frames shown each second.
3. **A** – 48 ÷ 12 = 4.
4. **B** – 10 × 30 = 300.
5. **A** – Cinema uses 24 fps.
6. **C** – Key frames mark changes.
7. **A** – Empty circle = nothing drawn yet.
8. **D** – Destination = where it arrives.
9. **B** – 13 − 1 − 1 = 11.
10. **A** – Each frame is your own drawing.
11. **C** – Shape tween changes the shape.
12. **C** – Motion tween changes position.
13. **B** – Animated GIFs loop and have no sound.
14. **D** – Pencil2D is for frame-by-frame animation.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

15. **C** – Flash ended in 2021; use MP4 or HTML5 now.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.