Video Answer Key B2
Upper intermediate

These answers correspond with the worksheet that accompanies Dr Hugh Hunt's lecture, *Boomerangs, Bouncing Balls and other Spinning Things*. This lecture can be found at www.cambridge.org/elt/lectureB2

This worksheet can be found at www.cambridge.org/elt/lectures along with a worksheet on Lecture skills – including note-taking skills – and more lectures.

Preparing for lectures

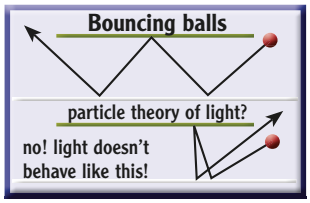
1.1 **a–c** The questions were asked to make you start thinking about the content of the lecture. In a real life situation, you may receive lecture titles and suggested reading before you attend lectures. It is a good idea to research as much as you can about the topic and see if you can find out some information about the lecturer and find out which lectures he will be delivering on your course. You will discover the answers to questions 1.1a – c as you watch the rest of the lecture.

B2 Extract 1 (starts at 00:00 and ends at 3:54)

1.2 **a** The theory of light using bouncing balls. Audioscript: I'm gonna start with a little demonstration to do with bouncing balls and what physicists would call, 'the particle theory of light'.

b Your notes might include some of the following points:

a beam of light reflects off a mirror: 'angle of incidence' = 'angle of reflection'



Waves reflect off a wall: angle of incoming waves = angle of the outgoing waves -> 'wave theory of light'

'Particle theory of light', photon = particle ... bounce along a wall.

c Audioscript: if the mirrors went on forever, then this light beam would keep on reflecting backwards and forwards a bit like an optic fibre.

d No, light would continue, but the ball bounces back into the lecturer's hand. Audioscript: The ball going in here is not going out the other end but it's coming back the way it came.

Listening for detail

B2 Extract 2 (starts at 03:54 and ends at 7:02)

2.1 **a** The balls starts to spin (just like an airplane wheel spins when the plane lands).

b The spin direction is reversed and this is called 'backspin'. Notice that the lecturer uses these expressions (in **bold**) to emphasise what he is demonstrating and repeat information: So we **notice** that the spin direction has changed. Let's turn this thing back up the right way again and **recap** what we've seen.

Audioscript: let's turn this whole thing [the table and slide] upside down … it's now backspin. And the ball - you would expect it to come back towards you - but again if we

make good observations have a look at what happens to the spin direction after that ball bounces. Can you see how the spin direction is reversed? … It's backspin, so it comes back the way it came and spins in the opposite direction and now we have topspin and it's gonna shoot out that way.

B2 Extract 3 (starts at 9:14 until 14:16)

2.2

a And then people say, 'Oh good you understand about spin then? How about you tell me how it is that a spinning top stays up?' A spinning top well a spinning top normally doesn't want to stay up. If I start it spinning and even then it won't stay up unless it's spinning fast enough. There we go. Spinning fast it stays up.

Why does it stay up? … It doesn't stay up when it's not spinning slowly, it still doesn't stay up but as soon as it spins fast enough it stays up.

So then we start thinking well what fun experiments can I do? … I'm going to attach this [stunt peg] onto a wheel, hold onto this string and hold this wheel up, seemingly counter to gravity. If the wheel's not spinning, then the wheel just collapses like that it falls down. If the wheel's not spinning fast enough then it falls down. But once the wheel is spinning fast enough then round it goes.

b The angle of the wheel has no effect on the speed of the turning wheel. Audioscript: The spinning, the precession rate here it actually is independent of the angle that this is tilted at, so that the rate at which it turns around doesn't matter if it's tilted so I can tilt it up at any angle I like and the rate at which it turns around is the same.

c Audioscript: It's an opportunity to start introducing some words like 'the gyroscopic effect' and this [turning, tilting] motion is called 'precession'.

d The earth is a spinning thing / spinning top.

(If you are interested in the topic and want to find out more about gyroscopic effect and Newton's 'law of motion', watch the lecture from 16:09 until 19:52. The Audioscript for the optional extract can be found at the end of the answer sheet.)

2.3a **1** b **2** f **3** a **4** e **5** c **6** d

B2 Extract 4 (starts at 19:54 and ends at 24:23)

2.4

1 circular motion
2 ordinary ball
3 constant speed
4 mass times acceleration
5 law of motion
6 change your direction
7 right angles
8 continuously changing
9 spin
10 momentum

2.5

1 The weight of the bottle of water
2 The amount of force applied
3 a vector/vectors

B2 Extract 5 (starts at 40:25 and ends at 43:31)

2.6

1 T
2 F. This is Newton's third law of motion.
3 T

2.7

1 lift
2 upwards
3 symmetrical
4 spin
5 front; faster

B2 Additional Extract (starts at 16:09 and ends at 19:52)

2.2d

The Audioscript for the optional extract if you are interested in the topic and want to find out more about gyroscopic effect and Newton's 'law of motion' follows:

None of what we are doing with this gyroscopic effect is anything other than an application of Newton's laws of motion. And Isaac Newton was a pretty clever guy and he was actually based here in Cambridge and he came up with laws of motion F equals M A force is mass times acceleration. So now all of this is, it's wonderful stuff, the gyroscopic effect actually all derives from Newton's laws of motion. Isaac Newton was an extraordinary mathematician he wanted to understand the world around him he was based here in Cambridge he was a Fellow of Trinity College this is the front page of the Principia it says here 'Isaac Newton Trin Coll Cantab a Lucasian Professor of Mathematics'. Stephen Hawking is the Lucasian Professor now, this was written in hmm Roman numerals … I'll have to think about that. But three hundred and fifty years ago he came up with this law F equals M A force is mass times acceleration. What this essentially means is that if you want to make something move you need to apply a force. But if something is currently moving it will carry on moving at its constant velocity constant speed unless you apply a force. Now Newton had to think of how to use his law because unfortunately Newton's law of motion only applies to a particle. It only applies to a single point mass because rotation involves bits of particles going in one direction and other particles going in the other direction um how do you keep track of all those particles? So Newton had to think about how to do that and so he applies his law to a particle which says if I apply a force I get an acceleration. And then he says well what if I have another particle? I can apply a force to that and have an acceleration and another one in fact I can have a few particles and they each independently obey Newton's law of motion. And then he sort of thought well let me get a few more particles and have them each independently obeying F equals M A and then I'll have a few more particles and maybe I'll have a few more particles. I've made myself a wheel. What I can now do is to think of a wheel as being made up of a zillion different particles each one of those particles acted upon by a force and the force, some of the forces, come from other particles nearby some of them come from gravity, some come from all over the place. Newton had to invent a way of doing this mathematically and what he said was I'm going to add up F equals M A for all the particles but because the particles are tiny weenie weenie and there's a billion zillion of them I can't just add them up by hand I'll have to add them up mathematically and he came up with this thing called the integral calculus which is just a glorified way of adding things up. So when you see this symbol in mathematics that's just Newton's symbol for adding things up.