Psychology Units 3 & 4

Chapter 8 — Importance of sleep to mental wellbeing

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Contents

Chapter 8 Importance of sleep to mental wellbeing — 8A Sleep deprivation and its effects

Theory

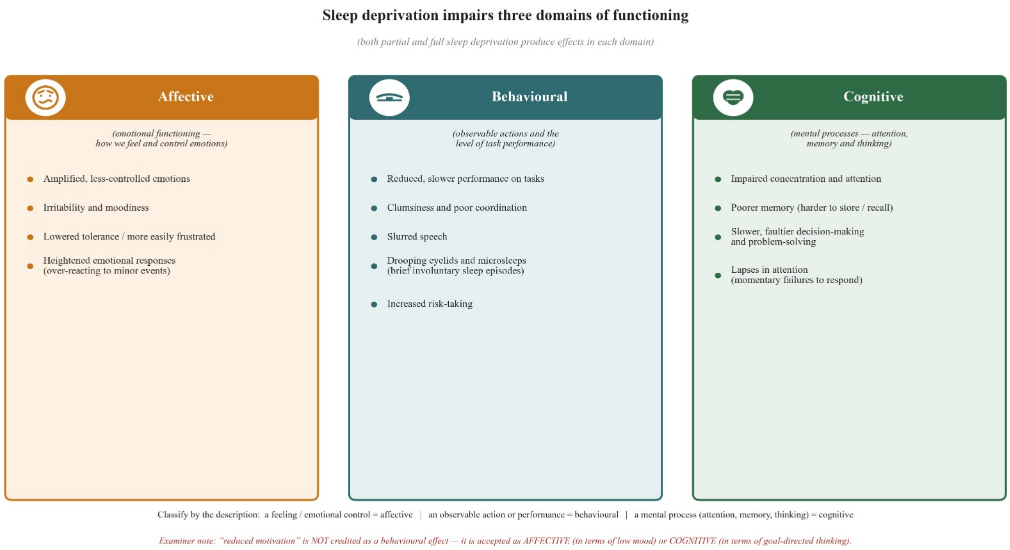
Sleep deprivation means not getting the sleep a person needs to function at their best. It is described in two forms, and its effects are grouped into three domains of functioning.

Two forms of sleep deprivation.

- **Partial sleep deprivation** — having *less sleep than is needed* over one or more nights. This is the everyday form. It can mean **reduced quantity** (too few hours — for example, several nights of only five hours) or **reduced quality** (broken, disrupted or non-restorative sleep, so that even a “normal” number of hours leaves the person unrefreshed). Because the shortfall can build up across successive nights, the effects of partial sleep deprivation tend to **accumulate**.
- **Full sleep deprivation** — going *without any sleep* for a period, defined as **at least 24 hours** (one full day–night) without sleep. It is also called total sleep deprivation.

Three domains of functioning. The effects of sleep deprivation are classified as affective, behavioural and cognitive.

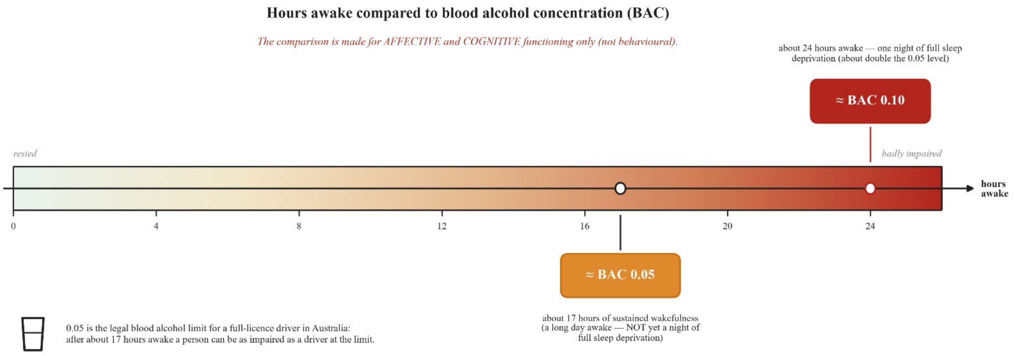
- **Affective (emotional) functioning** — how we experience and control emotions. Sleep-deprived people show **amplified, less-controlled emotions**: irritability and moodiness, lowered tolerance (more easily frustrated) and **heightened emotional responses** (over-reacting to minor events).
- **Behavioural functioning** — observable actions and the level of task performance. Effects include **reduced and slower performance**, **clumsiness** and poor coordination, **slurred speech**, **drooping eyelids and microsleeps** (brief, involuntary sleep episodes lasting a few seconds) and **increased risk-taking**.
- **Cognitive functioning** — mental processes such as attention, memory and thinking. Effects include **impaired concentration and attention**, **poorer memory** (harder to store and recall information), **slower and faultier decision-making and problem-solving**, and **lapses** in attention (momentary failures to respond).



How to classify an effect. Match the *description* to a domain: a **feeling** or a change in **emotional control** is **affective**; an **observable action, movement or level of performance** is **behavioural**; a **mental process** — attending, remembering, thinking or deciding — is **cognitive**. Some effects have more than one aspect (for example, risk-taking is an observable behaviour that is driven by impaired cognitive judgement); for classification, name the domain that the described symptom directly belongs to. One case is worth memorising because examiners have ruled on it: **reduced motivation** (“can’t be bothered”) is **not** credited as a behavioural effect. It is accepted as **affective** (in terms of *low mood*) **or** as **cognitive** (in terms of *decision-making and goal-directed thinking*) — motivation is an internal state, not an observable action. What is behavioural is the **drop in performance** that follows from it.

The blood-alcohol comparison (a landmark to learn precisely). To convey how impairing full sleep deprivation is, its effects are compared with a person's **blood alcohol concentration (BAC)**. Research shows that the **affective and cognitive** effects of full sleep deprivation are comparable to those of being affected by alcohol:

- After about **17 hours** of sustained wakefulness (a long day awake, before a whole night's sleep has been missed), affective and cognitive functioning is comparable to a **BAC of 0.05**.
- After about **24 hours** awake — one night of full sleep deprivation — it is comparable to a **BAC of 0.10**, about double the 0.05 level.



Two points examiners test. First, the comparison is made for **affective and cognitive** functioning — *not* behavioural. Second, keep the two values straight: about **17 hours → 0.05** and about **24 hours → 0.10**. Because **0.05** is the legal blood-alcohol limit for a full-licence driver in Australia, a person who has been awake for about 17 hours can be as impaired as a driver *at the legal limit* — which is why driving while badly sleep-deprived is so dangerous.

Worked examples

Example 1 — scaffolded

After a week of sleeping only about four hours a night while studying for exams, Priya notices that she snaps at her friends over small things, keeps re-reading the same paragraph without taking any of it in, and knocks over her coffee mug twice in one morning. Name the form of sleep deprivation Priya is experiencing, and classify each of the three described effects as affective, behavioural or cognitive.

Working	Comment
A week of about four hours a night = less sleep than needed over several nights → **partial sleep deprivation** (reduced quantity).	Partial = too little (or poor-quality) sleep across one or more nights.
"Snaps at friends over small things" = irritability and reduced emotional control → **affective**.	A change in emotion / emotional control is affective.
"Re-reads the same paragraph without taking it in" = impaired concentration and attention → **cognitive**.	A mental process (attention) is cognitive.
"Knocks over her coffee mug twice" = clumsiness / poor coordination → **behavioural**.	An observable action or drop in performance is behavioural.

Example 2 — scaffolded

A junior doctor finishes a hospital shift having been awake for about 17 hours. A colleague, who has now been awake for about 24 hours, offers to drive them both home. Using the blood-alcohol comparison, describe how each person's functioning is affected, state which domains the comparison applies to, and advise whether the colleague should drive.

Working	Comment
About **17 hours** awake → affective and cognitive functioning comparable to a **BAC of 0.05**.	Learn the first equivalence: ≈17 h → 0.05.

Working	Comment
About **24 hours** awake → comparable to a **BAC of 0.10**, roughly double the 0.05 level.	Learn the second equivalence: ≈24 h → 0.10.
The comparison covers **affective and cognitive** functioning, not behavioural.	The common examiner trap — do not claim it covers behavioural effects.
0.05 is the full-licence legal limit, so the colleague at ≈0.10 is well over it → they should **not** drive; a taxi or rideshare is safer.	Apply the comparison to the scenario, not just define it.

Example 3 — unscaffolded

A student writes: “After a week of broken sleep, Elias could not concentrate in class, made careless decisions in the practical, and could not be bothered starting his homework. These are all behavioural effects, because you can see them in what he does.” Identify and correct the errors in this classification.

The classification is **incorrect**. **Behavioural** functioning means the person’s **observable actions and level of task performance** — what they visibly do. Failing to **concentrate** and making **careless decisions** are **cognitive** effects, because attention and decision-making are *mental processes*, even though their consequences are eventually visible. “Could not be bothered” describes **reduced motivation**, which is credited as an **affective** effect (in terms of low mood) or a **cognitive** effect (in terms of goal-directed thinking) — it is not a behavioural effect. The student’s reasoning is also flawed: because *every* effect of sleep deprivation eventually shows up in something a person does, “you can see it” would make every effect behavioural. The test is what the **described symptom itself** is — a feeling, an observable action, or a mental process. A genuinely **behavioural** effect for Elias would be something directly observable, such as **slurred speech**, **clumsiness** or a **microsleep** at his desk. ∴ poor concentration and careless decisions are **cognitive** effects, “could not be bothered” is credited as **affective or cognitive**, and none of the three is behavioural.

Example 4 — unscaffolded

A student claims: “The blood-alcohol comparison shows that after 24 hours awake a person is as clumsy and uncoordinated as someone with a BAC of 0.10.” Evaluate this claim.

The claim is **partly correct**. The **value** is right: about **24 hours** awake — one night of full sleep deprivation — produces functioning comparable to a **BAC of 0.10**, about double the **0.05** legal limit for a full-licence driver in Australia. What the student gets wrong is **what the comparison covers**. The equivalence is stated for **affective and cognitive** functioning only — emotional control, attention, memory and decision-making. **Clumsiness and poor coordination are behavioural** effects, and behavioural functioning is **not** part of the stated comparison. Sleep deprivation certainly does produce behavioural effects (clumsiness, slurred speech, microsleeps), but the 0.05 and 0.10 figures are not claims about them. ∴ the student has the right BAC for the right number of hours but has applied it to the wrong domain of functioning.

Practice questions

Scaffolded

Q1. Define each of the following: (a) partial sleep deprivation; (b) full sleep deprivation; (c) a microsleep.

Q2. For each described effect, state whether it is **affective**, **behavioural** or **cognitive**: (a) becoming tearful and irritable over a minor inconvenience; (b) taking much longer to solve a problem and making careless errors; (c) slurred speech and drooping eyelids.

Q3. State the blood-alcohol comparison for full sleep deprivation: (a) approximately how many hours awake produce functioning comparable to a BAC of 0.05; (b) approximately how many hours awake produce functioning comparable to a BAC of 0.10; (c) name the two domains of functioning to which this comparison applies.

Q4. A student sleeps for a reasonable number of hours in total but wakes many times each night and feels unrefreshed each morning. (a) Which form of sleep deprivation is this an example of, and why? (b) Explain why this is best described as reduced sleep *quality* rather than reduced *quantity*. (c) Give one cognitive and one affective effect the student might experience the next day.

Q5. A shift worker has just finished a run of night shifts. For each of the following, name the domain of functioning affected and justify your choice: (a) they take more risks than usual while driving home; (b) they cannot remember whether they locked the front door; (c) they feel unusually short-tempered with their family.

Q6. With reference to the effects of sleep deprivation: (a) explain what is meant by an *affective* effect, and give one example; (b) explain what is meant by a *cognitive* effect, and give one example; (c) state why the blood-alcohol comparison is said to describe both of these domains but not behavioural effects.

Unscaffolded

Q7. Distinguish between partial and full sleep deprivation. *(2 marks)*

Q8. Identify the three domains of functioning affected by sleep deprivation and give one example effect of each. *(3 marks)*

Q9. Explain what a microsleep is, and state which domain of functioning it belongs to. *(2 marks)*

Q10. State the two blood-alcohol-concentration equivalences for full sleep deprivation, including the approximate number of hours awake for each. *(2 marks)*

Q11. A student claims: "Going 24 hours without sleep leaves you comparable to a BAC of only 0.05." Identify and correct the error in this claim. *(2 marks)*

Q12. Explain why a person who has been awake for about 17 hours should be cautious about driving, referring to the blood-alcohol comparison. *(3 marks)*

Q13. For each of the following, classify the effect as **affective**, **behavioural** or **cognitive**: (a) forgetting an item that was on a shopping list; (b) laughing and then becoming tearful within minutes over trivial things; (c) fumbling and dropping equipment while packing up after training; (d) taking much longer than usual to decide which route to drive. *(4 marks)*

Q14. *Research scenario.* A psychologist tests whether one night of full sleep deprivation impairs concentration. Twenty volunteers each complete a computerised attention task twice: once after a normal night's sleep, and once after being kept awake for 24 hours. The number of attention lapses on the task is recorded each time. (a) Identify the independent variable and the dependent variable. (b) Write a directional (one-tailed) hypothesis for this investigation. (c) The volunteers recorded more lapses after being kept awake. Which domain of functioning does this measure, and does the result support the hypothesis? *(5 marks)*

Q15. *Data stimulus.* In an investigation, one participant completed the same reaction-time task at three points while being kept awake. Their results are shown below.

Hours awake	Mean reaction time (ms)	Mean lapses per 10 min
3 (baseline)	250	1
17	300	4
24	375	9

(a) Calculate the percentage increase in mean reaction time from baseline (3 hours awake) to 24 hours awake. *(1 mark)*
(b) At which value of "hours awake" would the participant's affective and cognitive functioning be expected to be comparable to a BAC of 0.05? *(1 mark)*
(c) Using the data, describe the relationship between hours awake and task performance. *(2 marks)*

Q16. Explain why *increased risk-taking* after sleep deprivation is classified as a **behavioural** effect, and give one reason a sleep-deprived person may take more risks. *(3 marks)*

Q17. Distinguish between the affective and behavioural effects of partial sleep deprivation, using an example of each. *(4 marks)*

Q18. *Applied.* Over three consecutive nights before a tournament, a 16-year-old athlete sleeps only about five hours a night instead of her usual nine. (a) Name the form of sleep deprivation she is experiencing. *(1 mark)* (b) Describe one affective, one behavioural and one cognitive effect this may have on her the next day. *(3 marks)* (c) Explain why the effects of partial sleep deprivation can worsen across several nights. *(2 marks)*

Q19. Compare the effects on functioning of about 17 hours of sustained wakefulness with about 24 hours awake (one night of full sleep deprivation), referring to the blood-alcohol comparison. *(3 marks)*

Q20. *Extended response.* “One night without sleep can be as dangerous as drink-driving.” Using the affective, behavioural and cognitive effects of sleep deprivation and the blood-alcohol-concentration comparison, evaluate this statement. In your response, distinguish partial from full sleep deprivation, give an example effect from each of the three domains, and state precisely what the blood-alcohol comparison does and does not cover. *(6 marks)*

Answers

Q1. (a) Having less sleep than needed over one or more nights (reduced quantity or quality). (b) Going without any sleep for a sustained period — at least 24 hours awake. (c) A brief, involuntary episode of sleep lasting a few seconds. **Q2.** (a) affective; (b) cognitive; (c) behavioural. **Q3.** (a) About 17 hours. (b) About 24 hours. (c) Affective and cognitive functioning. **Q4.** (a) Partial sleep deprivation — it is insufficient/inadequate sleep over one or more nights. (b) The hours are adequate but the sleep is broken and non-restorative, so it is a quality, not a quantity, problem. (c) e.g. cognitive = poorer concentration; affective = irritability. **Q5.** (a) Behavioural — risk-taking is an observable action. (b) Cognitive — memory is a mental process. (c) Affective — short temper is an emotional/emotional-control change. **Q6.** (a) An effect on emotion or emotional control, e.g. irritability. (b) An effect on a mental process, e.g. impaired concentration. (c) The 0.05 and 0.10 equivalences are stated for affective and cognitive functioning only; behavioural effects are not part of the comparison. **Q7.** Partial = some but insufficient (or poor-quality) sleep over one or more nights; full = no sleep at all for at least 24 hours. **Q8.** Affective (e.g. irritability); behavioural (e.g. slurred speech / microsleeps); cognitive (e.g. impaired concentration). **Q9.** A microsleep is a brief, involuntary episode of sleep lasting a few seconds; it is a behavioural effect. **Q10.** About 17 hours awake ≈ BAC 0.05; about 24 hours awake ≈ BAC 0.10. **Q11.** Error: 24 hours awake is comparable to BAC 0.10, not 0.05; a BAC of 0.05 corresponds to about 17 hours awake. **Q12.** About 17 hours awake ≈ BAC 0.05, the full-licence legal limit; affective and cognitive functioning (attention, decision-making, emotional control) is impaired, raising crash risk. **Q13.** (a) cognitive; (b) affective; (c) behavioural; (d) cognitive. **Q14.** (a) IV = amount of sleep (normal night's sleep vs 24 hours of full sleep deprivation); DV = number of attention lapses. (b) Directional hypothesis naming both IV levels and the predicted direction. (c) Cognitive (attention); yes, more lapses supports the hypothesis. **Q15.** (a) 50%. (b) 17 hours awake. (c) As hours awake increase, reaction time and lapses increase — performance worsens. **Q16.** Risk-taking is an observable action (behavioural); it increases because impaired judgement / reduced emotional control leads to poorer, riskier choices. **Q17.** Affective = an emotional change (e.g. irritability); behavioural = an observable action/performance change (e.g. clumsiness). Both, with examples. **Q18.** (a) Partial sleep deprivation. (b) e.g. affective = moodiness; behavioural = slower/clumsier movement; cognitive = poorer concentration. (c) The nightly shortfall accumulates (sleep debt), so effects build up. **Q19.** 17 h ≈ BAC 0.05 (≈ legal limit); 24 h ≈ BAC 0.10 (about double); both describe affective and cognitive functioning; impairment is greater at 24 hours. **Q20.** Model response given in the solutions.

Fully-worked solutions

Q1. (a) **Partial sleep deprivation** is having *less sleep than is needed* over one or more nights — either too few hours (reduced quantity) or broken, non-restorative sleep (reduced quality). (b) **Full sleep deprivation** is going *without any sleep* for a sustained period, defined as at least 24 hours awake. (c) A **microsleep** is a brief, involuntary episode of sleep — typically lasting only a few seconds — that intrudes into wakefulness when a person is very sleep-deprived.

Q2. (a) **Affective** — becoming tearful and irritable is a change in emotion and emotional control. (b) **Cognitive** — solving a problem and avoiding careless errors are mental processes (thinking and attention). (c) **Behavioural** — slurred speech and drooping eyelids are observable actions/signs.

Q3. (a) About **17 hours** awake produces affective and cognitive functioning comparable to a **BAC of 0.05**. (b) About **24 hours** awake produces functioning comparable to a **BAC of 0.10**. (c) The comparison applies to **affective and cognitive** functioning.

Q4. (a) This is **partial sleep deprivation**, because it is *inadequate* sleep over one or more nights rather than a total absence of sleep. (b) The student gets an adequate *number of hours*, so the problem is not quantity; because the sleep is **broken and non-restorative** (frequent waking, feeling unrefreshed), it is a reduction in sleep **quality**. (c) For example, a **cognitive** effect such as poorer concentration or memory, and an **affective** effect such as irritability or moodiness.

Q5. (a) **Behavioural** — taking more risks while driving is an *observable action*, so it is classified as a behavioural effect. (b) **Cognitive** — remembering whether the door was locked relies on **memory**, a mental process, so this is a cognitive effect. (c) **Affective** — being short-tempered is a change in **emotion and emotional control**, so it is an affective effect.

Q6. (a) An **affective effect** is an effect on **emotion or emotional control** — for example, increased **irritability** or over-reacting emotionally to minor events. (b) A **cognitive effect** is an effect on a **mental process** such as attention, memory or thinking — for example, **impaired concentration** or slower decision-making. (c) The blood-alcohol comparison is **stated only for affective and cognitive functioning**; the effects of full sleep deprivation on these two domains are what research found to be comparable to a given BAC. Behavioural effects are real but are **not part of the stated equivalence**, so the comparison is said to cover affective and cognitive functioning but not behavioural functioning.

Q7. Partial sleep deprivation is having *some but insufficient* sleep — too few hours or poor-quality, broken sleep — over one or more nights. **Full sleep deprivation** is having *no sleep at all* for a sustained period (at least 24 hours awake). The key contrast is *insufficient* sleep versus a *complete absence* of sleep.

Q8. The three domains are **affective**, **behavioural** and **cognitive**. An **affective** effect is, for example, **irritability** or amplified emotions; a **behavioural** effect is, for example, **slurred speech**, clumsiness or a microsleep; a **cognitive** effect is, for example, **impaired concentration** or poorer memory.

Q9. A **microsleep** is a **brief, involuntary episode of sleep**, usually lasting only a few seconds, that intrudes into wakefulness in a sleep-deprived person (often with drooping eyelids and a momentary loss of awareness). Because it is an **observable action/state** rather than a feeling or a mental process, it is classified as a **behavioural** effect.

Q10. After about **17 hours** awake, affective and cognitive functioning is comparable to a **BAC of 0.05**. After about **24 hours** awake, it is comparable to a **BAC of 0.10**.

Q11. The claim is **incorrect**. After about **24 hours** without sleep, affective and cognitive functioning is comparable to a **BAC of 0.10**, not 0.05. A **BAC of 0.05** corresponds to about **17 hours** awake, not 24. (The student has swapped the two equivalences.)

Q12. After about **17 hours** awake, a person's affective and cognitive functioning is comparable to a **BAC of 0.05** — which is the **legal blood-alcohol limit** for a full-licence driver in Australia. This means their **attention, decision-making and emotional control** are impaired to a degree comparable to a driver *at the legal limit*, which **increases the risk of a crash**. They should therefore be cautious about driving (or avoid driving) after being awake this long.

Q13. (a) **Cognitive** — remembering a list item relies on memory. (b) **Affective** — rapid, poorly controlled emotional swings are emotional. (c) **Behavioural** — fumbling and dropping equipment is clumsiness and poor coordination, an *observable action*. (d) **Cognitive** — deciding which route to take is decision-making, a mental process.

Q14. (a) The **independent variable** is the **amount of sleep** the volunteers had — a normal night's sleep versus 24 hours of full sleep deprivation. The **dependent variable** is the **number of attention lapses** recorded on the computerised task. (b) A suitable **directional hypothesis** is: *It was hypothesised that volunteers who had been kept awake for 24 hours (full sleep deprivation) would record more attention lapses on the computerised task than after a normal night's sleep.* (This names both levels of the IV and predicts the direction of the effect.) (c) Attention lapses measure **cognitive** functioning (concentration/attention). Because more lapses occurred after sleep deprivation, the result **supports** the hypothesis.

Q15. (a) The increase is from 250 ms to 375 ms, a rise of 125 ms. As a percentage of baseline: $125 \div 250 \times 100 =$ **50%**. (b) At about **17 hours** awake, affective and cognitive functioning is expected to be comparable to a **BAC of 0.05**. (c) As **hours awake increase, mean reaction time and the number of lapses both increase** — that is, task performance steadily **worsens** the longer the participant goes without sleep.

Q16. Increased risk-taking is classified as behavioural because it is an **observable action** — we can see the riskier choices the person makes (for example, overtaking in an unsafe gap or crossing against a light). One reason a sleep-deprived person takes more risks is that their **cognitive judgement and decision-making are impaired** and their **emotional control is reduced**, so they weigh consequences poorly and act more impulsively than when well rested.

Q17. An **affective effect** of partial sleep deprivation is a change in **emotion or emotional control** — for example, becoming **irritable** and over-reacting to a minor annoyance. A **behavioural effect** is a change in an **observable action or level of performance** — for example, becoming **clumsy** and knocking things over, or slurring speech. The two differ in kind: the affective effect concerns *how the person feels and manages emotion*, whereas the behavioural effect concerns *what the person visibly does or how well they perform*.

Q18. (a) **Partial sleep deprivation** (reduced quantity over several nights). (b) For example: an **affective** effect such as **moodiness or irritability**; a **behavioural** effect such as **slower, clumsier movement** or reduced coordination in her sport; and a **cognitive** effect such as **poorer concentration** or slower decision-making during play. (c) Because each night she sleeps less than she needs, the **shortfall accumulates** across the three nights (a growing "sleep debt"), so she becomes progressively more deprived and the effects on her functioning **worsen** night after night.

Q19. After about **17 hours** awake, affective and cognitive functioning is comparable to a **BAC of 0.05** — the full-licence legal driving limit. After about **24 hours** awake, functioning is comparable to a **BAC of 0.10**, which is **about double** the 0.05 level, so the impairment is **greater**. In both cases the comparison describes **affective and cognitive** functioning. The key difference is one of **degree**: 24 hours of full sleep deprivation produces markedly worse impairment than 17 hours.

Q20. *Model response (6 marks).* The statement is **largely supported**, though it must be stated carefully. **Sleep deprivation** comes in two forms: **partial** (less sleep than needed over one or more nights — reduced quantity or quality) and **full** (no sleep at all for at least 24 hours). "One night without sleep" describes **full sleep deprivation** of about a day. Its effects appear across three domains: an **affective** effect such as **irritability** and reduced emotional control; a **behavioural** effect such as **microsleeps** or slurred, clumsy movement; and a **cognitive** effect such as **impaired concentration** and slower decision-making. The comparison with drink-driving is apt because research shows the **affective and cognitive** effects of full sleep deprivation are comparable to a measured blood alcohol concentration: about **17 hours** awake is comparable to a **BAC of 0.05** (the full-licence legal limit), and about **24 hours** awake is comparable to a **BAC of 0.10**. So a person driving after a night without sleep can be as impaired as a driver over the legal limit, which supports the statement. However, the claim must be **qualified**: the 0.05 and 0.10 equivalences are stated for **affective and cognitive** functioning **only**, not for behavioural functioning, and they describe *comparable impairment*, not identical causes. ∴ overall the statement is justified — one night of full sleep deprivation can leave affective and cognitive functioning as impaired as an over-the-limit drink-driver — provided we remember the comparison is specific to affective and cognitive functioning. *(Full marks require: partial vs full distinguished; one example effect from each of the three domains; both BAC equivalences with their approximate hours; an explicit statement that the comparison covers affective and cognitive functioning only; and a judgement.)*

Theory

The **sleep-wake cycle** is a **circadian rhythm** — a biological rhythm with a period of about 24 hours. As covered in Chapter 7, it is coordinated by the **suprachiasmatic nucleus (SCN)**, the brain's master clock, which uses **light** detected by the eyes to time the release of the sleep hormone **melatonin**. Normally this internal clock is kept in step (entrained) with the outside day so that we feel sleepy at night and alert by day, in time with our commitments.

A **circadian rhythm sleep disorder** is a persistent mismatch (misalignment) between the timing of a person's **internal** sleep-wake cycle and the timing that their **external** environment or schedule requires. The crucial point is that the sleep itself is usually **normal in amount and quality when the person is allowed to follow their own body clock** — what is wrong is that the clock is set to the "wrong" time relative to social demands (school, work, family), so the person cannot sleep and wake when they need to.

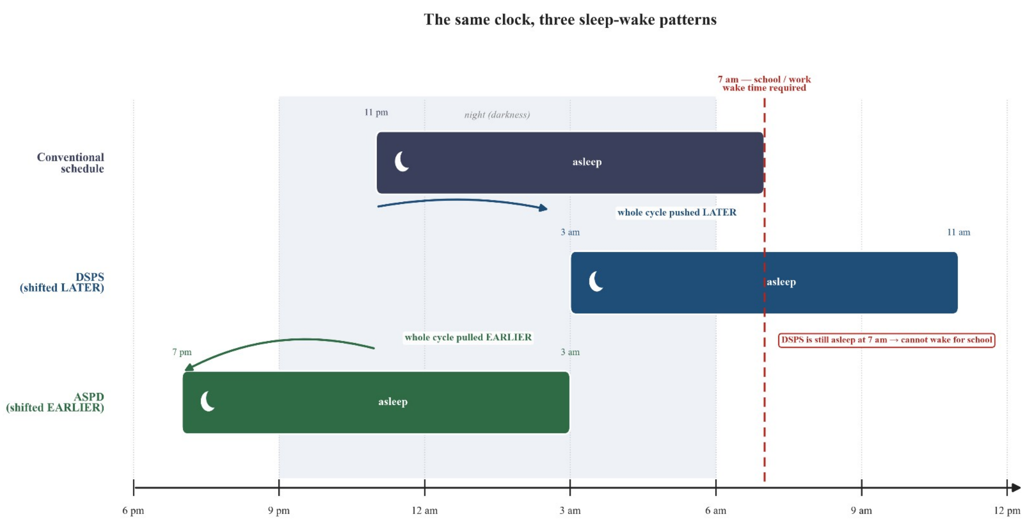
Circadian disorder versus sleep deprivation. This is the distinction examiners test most. In a circadian rhythm sleep disorder the **timing** of sleep is misaligned; given a free schedule, the person sleeps a normal length and feels rested. In **sleep deprivation** the **amount** of sleep is insufficient — the person does not get enough sleep regardless of when it is timed. A person with a circadian disorder often *becomes* sleep-deprived as a knock-on effect (because the required schedule cuts their sleep short), but the underlying problem is misaligned timing, not an inability to sleep.

The study design names three changes to the sleep-wake cycle that can cause a circadian rhythm sleep disorder.

1. Delayed Sleep Phase Syndrome (DSPS). The sleep-wake cycle is shifted **later** than the conventional or desired schedule. The person cannot fall asleep until very late (often 2–4 am) and, left to themselves, would not wake until late morning. If they are allowed to follow this delayed schedule (for example on weekends or holidays) they sleep a normal length and wake refreshed. Problems appear when **morning commitments** force an early wake time: the person is woken part-way through their sleep, loses sleep and is chronically tired through the day. DSPS is **most common in adolescents**, whose circadian rhythm naturally shifts a little later during puberty.

2. Advanced Sleep Phase Disorder (ASPD). The sleep-wake cycle is shifted **earlier** than conventional. The person feels sleepy in the **early evening** (often 6–8 pm) and wakes **very early** in the morning (often 3–4 am), unable to fall back asleep. Again the sleep itself is essentially normal in length; the difficulty is that the early timing clashes with normal evening activities (they cannot stay awake for them) and with the wish to sleep until a normal hour. ASPD is **more common in older adults**.

> **Watch the trap. D**elayed = shifted **later**; **A**dvanced = shifted **earlier**. Students routinely swap these. "Delayed" means sleep is pushed **back** to a later time; "advanced" means it is brought **forward** to an earlier time.



3. Shift work. Shift work means working hours that fall outside the standard daytime pattern — especially **night shifts** and **rotating rosters**. It forces a person to be awake and working **at night**, when the **external** cue of darkness and their **internal** clock (with melatonin high) are both promoting sleep, and to try to sleep **during the day**, when daylight and the clock are promoting wakefulness. The result is a **misalignment** between the internal clock and the required schedule: daytime sleep is shorter and lighter, and night-time alertness is reduced, causing sleep loss, on-shift sleepiness and impaired concentration and performance. **Rotating** rosters make this worse because the clock never has time to entrain to a stable pattern.

How the three differ. In **DSPS** and **ASPD** the person's **own internal clock** is shifted (later or earlier) relative to convention. In **shift work** the change is **externally imposed** — the person's clock may be normally timed, but their work forces sleep and wake at times that conflict with it.

Treatment — bright light therapy. Because light is the main cue the SCN uses to set the clock (recall the light → retina → SCN → pineal gland → melatonin pathway from Chapter 7), carefully **timed** exposure to **bright light** can shift the circadian rhythm in a chosen direction. Bright light therapy uses timed exposure to a bright light source (a light box, or natural sunlight) to move the sleep-wake cycle. The mechanism is the same every time: the bright light is **registered by the SCN**, which then **changes the timing of the pineal gland's release of melatonin**, resetting the clock. **The direction of the shift depends on when the light is given:**

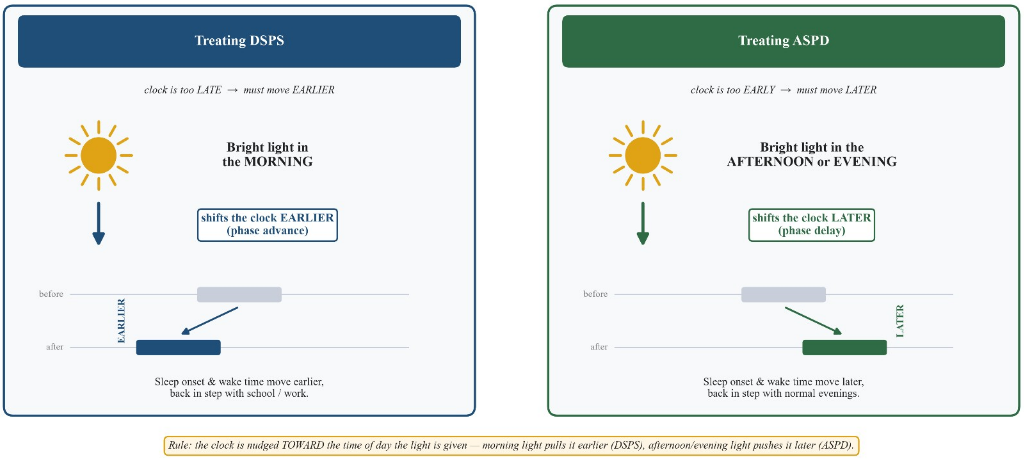
- Bright light in the **morning** shifts the clock **earlier** (a *phase advance*): the SCN registers the light and suppresses melatonin early, signalling that the day has begun, so sleep onset and wake time are pulled earlier. Morning light is therefore used to treat **DSPS**, whose clock is too late and needs to move **earlier**.
- Bright light in the **late afternoon or evening** shifts the clock **later** (a *phase delay*): the SCN registers the light late in the day and holds back the evening rise of melatonin, so sleep onset and wake time are pushed later. Afternoon or evening light is therefore used to treat **ASPD**, whose clock is too early and needs to move **later**.

Name the SCN — melatonin on its own is not enough. Assessors have repeatedly withheld marks from answers that explain bright light therapy through melatonin alone. Whenever you are asked *how* or *why* the light moves the clock, write the whole chain: **bright light → registered by the SCN → the SCN changes the pineal gland's release of melatonin → sleep onset and wake time shift**. Note that melatonin is released by the **pineal gland**, not by the SCN — saying the SCN releases it is a commonly penalised error.

Afternoon or evening for ASPD? Either is accepted. What matters is that the light comes **late in the person's day**, after their (early) body clock has begun signalling sleep, so it holds melatonin back and delays the clock. The contrast that must be right is **light early in the day = advance** versus **light late in the day = delay**; "afternoon", "late afternoon" and "evening" all sit on the "late" side for ASPD.

The direction must be stated precisely — getting it backwards is the classic exam error. A simple rule: **the clock is nudged toward the time of day the light is given** — morning light pulls the cycle earlier (treats DSPS); afternoon or evening light pushes it later (treats ASPD). For **shift workers**, the same principle is applied to help the clock tolerate night work — for example, bright light **during** the night shift to promote alertness, and **avoiding** bright morning light on the way home (such as by wearing dark glasses) so the clock is not dragged back the wrong way before daytime sleep.

Bright light therapy: the timing sets the direction of the shift



Analysing a scenario. (1) Decide whether the problem is **misaligned timing** (a circadian disorder) or **too little sleep overall** (deprivation) — ask whether the person sleeps normally when free to choose their own hours. (2) If it is a circadian disorder, decide the **direction** of the shift: sleep too **late** = DSPS; sleep too **early** = ASPD; sleep forced against the clock by irregular hours = shift work. (3) For treatment, match the **light timing** to the direction the clock must move: **morning light** to move earlier (DSPS), **afternoon or evening light** to move later (ASPD) — and in each case say that the light is registered by the **SCN**, which then shifts the timing of **melatonin** release.

Worked examples

Example 1 — scaffolded

Tomas, aged 16, cannot fall asleep until about 2:30 am no matter how early he goes to bed, and when he is free to (weekends, holidays) he sleeps soundly until about 10:30 am and wakes feeling refreshed. On school days he must wake at 7 am and is exhausted all day. Identify the circadian rhythm sleep disorder, state the direction his sleep-wake cycle is shifted, and explain why he is exhausted on school days but not on holidays.

Working	Comment
His sleep-wake cycle is shifted **later** than conventional — asleep ~2:30 am, would wake ~10:30 am → **Delayed Sleep Phase Syndrome (DSPS)**.	Delayed = shifted **later**. Name the disorder from the direction of the shift.
On holidays he follows his own delayed clock, gets a full ~8 hours and wakes refreshed → his sleep itself is **normal**.	The hallmark of a circadian disorder: normal sleep when free to follow the body clock.
On school days he is woken at 7 am, only part-way through his sleep (~4.5 hours), so he becomes **sleep-deprived**.	The clash with the **required** wake time cuts his sleep short — the timing is the problem, not the sleep.

So the disorder is **DSPS**, his cycle is shifted **later**, and his school-day exhaustion comes from the **mismatch** between his late body clock and the early wake time required — not from an inability to sleep.

Example 2 — scaffolded

For Tomas (Example 1), recommend bright light therapy: state **when** he should use a light box and explain, in terms of the direction his clock must move, why that timing is correct.

Working	Comment
DSPS means his clock is too **late**; to fix it the clock must shift **earlier**.	Decide the required direction of the shift first.
Morning bright light shifts the clock **earlier**: the **SCN** registers the light and cuts short the pineal gland's	Always route the explanation through the **SCN**, then melatonin — melatonin alone loses marks.

Working	Comment
melatonin release, signalling the day has begun.	
So Tomas should use bright light in the **morning**, soon after waking.	Morning light for DSPS (a phase advance).
Evening light would shift his clock **later** and make DSPS worse — the classic error to avoid.	Pre-empt the reverse-direction mistake.

Tomas should use bright light in the **morning**, because the SCN registers morning light and produces a phase **advance** that moves his sleep onset and wake time **earlier**, back in step with school.

Example 3 — unscaffolded

Margaret, aged 64, finds she cannot keep her eyes open past about 6:45 pm and is wide awake for the day by about 3:15 am, unable to get back to sleep; she has had to give up her Tuesday evening choir practice. Identify her disorder and the direction of the shift, and recommend bright light therapy with the correct timing, justifying the direction.

Margaret's sleep-wake cycle is shifted **earlier** than conventional — sleepy by 6:45 pm, awake at 3:15 am — which is **Advanced Sleep Phase Disorder (ASPD)**; her sleep length is roughly normal, but its timing is too early. To treat ASPD her clock must move **later**, so she should use bright light **late in the day — in the afternoon or evening**. Late-day light produces a phase **delay**: the **SCN** registers it and holds back the pineal gland's evening release of melatonin, pushing sleep onset and wake time later, so she can stay awake for choir and wake at a more normal hour. Morning light would move her clock **earlier** and worsen the disorder. ∴ ASPD (shifted earlier); treat with **afternoon or evening** bright light, which acts via the SCN and melatonin to delay the clock later.

Example 4 — unscaffolded

Yusuf works as a security guard on a permanent overnight shift, midnight to 8 am. He sleeps only in short, broken stretches after he gets home, and by the last hours of each shift he is struggling to stay alert on his rounds. Explain, using the circadian rhythm, why he sleeps poorly and feels impaired, and distinguish his situation from a person who has DSPS.

Yusuf's roster forces him to be awake at night and to sleep during the day, which **conflicts with his circadian rhythm**. Through the night the darkness and his own clock are both promoting sleep (melatonin is high), so he is fighting a sleep signal in the last hours of the shift and struggles to stay alert; after 8 am, daylight and his clock are promoting wakefulness, so his daytime sleep is **short and broken** and he becomes sleep-deprived. This is **shift work** — an **externally imposed** misalignment between the required schedule and a clock that is not itself abnormal. It differs from **DSPS**, in which the person's **own internal clock** is shifted **later**; a person with DSPS who is **allowed** to follow their late schedule sleeps normally, whereas Yusuf's problem is the **conflict** his roster forces on a normally timed clock. ∴ shift work causes an externally imposed circadian misalignment, unlike DSPS where the internal clock itself is delayed.

Practice questions

Scaffolded

Q1. Define each of the following: (a) circadian rhythm sleep disorder; (b) Delayed Sleep Phase Syndrome (DSPS); (c) Advanced Sleep Phase Disorder (ASPD).

Q2. Liang, aged 15, lies awake until nearly 2 am each night and, when free of commitments, sleeps until midday and wakes refreshed. On school mornings he must be up at 6:45 am and is drowsy all day. (a) Name the circadian rhythm sleep disorder Liang most likely has. (b) State the direction in which his sleep-wake cycle is shifted. (c) Explain why Liang sleeps well on holidays but is drowsy on school days.

Q3. Bright light therapy is recommended for Liang (Q2). (a) State the time of day he should be exposed to bright light. (b) State the direction this shifts his circadian clock. (c) Explain, with reference to the SCN and melatonin, why light at that time of day produces that shift.

Q4. Beatrice, aged 68, falls asleep on the couch by 7:30 pm and wakes for good at about 4 am. (a) Name the circadian rhythm sleep disorder she most likely has. (b) State the direction in which her sleep-wake cycle is shifted. (c) State when she should use bright light therapy and the direction it will shift her clock.

Q5. A factory operates a permanent overnight shift from 11 pm to 7 am. (a) Define shift work. (b) Explain why working this shift disrupts a worker's sleep-wake cycle. (c) Explain why the workers' daytime sleep tends to be shorter and lighter than normal night-time sleep.

Q6. A student says, "A circadian rhythm sleep disorder and sleep deprivation are the same thing — both just mean you are tired." (a) State the key difference between a circadian rhythm sleep disorder and sleep deprivation. (b) Explain how a person with a circadian disorder can also become sleep-deprived. (c) State what you would ask about the person's sleep to decide which explanation fits.

Unscaffolded

Q7. Distinguish between Delayed Sleep Phase Syndrome and Advanced Sleep Phase Disorder. *(2 marks)*

Q8. Noah, aged 17, routinely falls asleep around 3 am and cannot wake for his 8 am classes; on holidays he sleeps from 3 am to 11 am and feels fine. Identify his disorder, state the direction his cycle is shifted, and recommend bright light therapy with the correct timing. *(3 marks)*

Q9. Colin, aged 74, is asleep by 8 pm and wide awake at 4 am each day. Identify his disorder and explain why bright light **late in the day (afternoon or evening)**, rather than in the morning, is appropriate for him. *(3 marks)*

Q10. A long-haul freight driver works irregular overnight runs and struggles to sleep when he gets home in the morning. Using the circadian rhythm, explain why his sleep is disrupted, and explain why a **rotating** roster would be harder for his body clock than a **fixed** one. *(4 marks)*

Q11. For **each** of DSPS and ASPD, state the time of day bright light therapy should be given and justify why that timing shifts the clock in the required direction. *(4 marks)*

Q12. A student with DSPS reads that "bright light therapy resets the body clock" and decides to sit under a bright lamp for an hour **before bed each evening** to fix it. Identify and correct the error in their plan. *(3 marks)*

Q13. Two students are both tired at school. Student A gets into bed at 10 pm but scrolls on their phone and only gets 5 hours' sleep on any night, weekend or not. Student B falls asleep at 2 am and wakes at 7 am on school days, but sleeps 2 am–10 am and feels fine on weekends. Identify which student best illustrates a **circadian rhythm sleep disorder** and which illustrates **sleep deprivation**, and justify your answer. *(4 marks)*

Q14. A sleep clinic sees a client who feels sleepy by 6:30 pm, wakes at 3 am and cannot get back to sleep, and whose sleep is a normal length when measured. Identify the disorder, state the direction of the shift, and recommend a treatment with the correct timing. *(3 marks)*

Q15. *Research scenario.* A researcher tests whether morning bright light improves DSPS. Forty adolescents diagnosed with DSPS are randomly allocated to two groups: one group receives 30 minutes of bright light (10 000 lux) each morning for two weeks; the other receives no light. Each participant's sleep-onset time is recorded before and after. (a) Identify the independent variable and the dependent variable. (b) Write a directional hypothesis that names both levels of the independent variable and the direction of the dependent variable. (c) Identify one extraneous variable that should be controlled and explain how it could affect the results. *(5 marks)*

Q16. *Data interpretation.* A clinic records the mean sleep-onset time of 12 DSPS patients before and after three weeks of morning bright light therapy.

	Mean sleep-onset time	SD
Before therapy	2:40 am	35 min
After therapy	12:15 am	28 min

(a) State whether the therapy shifted the clock in the intended direction for DSPS, and justify your answer using the data.

(b) Explain what the change in sleep-onset time shows about the direction the circadian rhythm moved.

(c) Give one reason the clinic should be cautious about concluding that the therapy **caused** the change. *(4 marks)*

Q17. A nurse on permanent night shift is advised to use bright light **during** her shift and to wear dark glasses on the drive home after sunrise. Explain how each measure helps her body clock cope with night work. *(3 marks)*

Q18. Explain why a person with a circadian rhythm sleep disorder can sleep a normal length and feel rested when they are free to follow their own schedule, yet be exhausted on work or school days. *(3 marks)*

Q19. Shift work is grouped with DSPS and ASPD as a change to the sleep-wake cycle that can cause a circadian rhythm sleep disorder, yet the change it involves is different in kind from the change in DSPS and ASPD. Explain that difference, and explain how a night-shift worker whose own body clock has **not** shifted can nonetheless develop a circadian rhythm sleep disorder. *(4 marks)*

Q20. *Extended response.* Explain the biological mechanism by which bright light therapy shifts the sleep-wake cycle, then explain how that same mechanism is applied differently for a person with Delayed Sleep Phase Syndrome, a person with Advanced Sleep Phase Disorder, and a worker on permanent night shift. In each case state when the light is given and which way the clock moves. *(6 marks)*

Answers

Q1. (a) A persistent misalignment between the timing of a person's internal sleep-wake cycle and the timing their external schedule requires. (b) A disorder in which the sleep-wake cycle is shifted later than desired, so the person cannot sleep until very late and struggles to wake in the morning. (c) A disorder in which the sleep-wake cycle is shifted earlier than desired, so the person is sleepy in the early evening and wakes very early. **Q2.** (a) DSPS. (b) Shifted later. (c) On holidays he follows his own late clock and gets a full night's sleep; on school days the early wake time cuts his sleep short, so he is sleep-deprived and drowsy. **Q3.** (a) In the morning. (b) Earlier (a phase advance). (c) The SCN registers the morning light and suppresses the pineal gland's melatonin release early, signalling the day has begun, so sleep onset and wake time are pulled earlier. **Q4.** (a) ASPD. (b) Shifted earlier. (c) Bright light in the afternoon or evening, which shifts her clock later. **Q5.** (a) Working hours outside the standard daytime pattern, especially night or rotating shifts. (b) It forces them to be awake when their clock and the darkness promote sleep and to sleep when daylight promotes wakefulness, causing misalignment. (c) Daytime sleep fights the clock and daylight (which promote wakefulness), so it is shorter and lighter. **Q6.** (a) A circadian disorder is misaligned **timing** of sleep (normal amount if free to choose); deprivation is insufficient **amount** of sleep. (b) The required schedule cuts their misaligned sleep short, so they end up with too little sleep. (c) Ask whether they sleep a normal length and feel rested when free to follow their own hours. **Q7.** DSPS = sleep-wake cycle shifted later (sleeps and wakes too late); ASPD = shifted earlier (sleeps and wakes too early). **Q8.** DSPS; shifted later; use bright light in the morning (shifts the clock earlier). **Q9.** ASPD; his clock is too early and must move later, so afternoon or evening light (registered by the SCN, which holds melatonin back and delays the clock) is appropriate; morning light would shift it earlier and worsen it. **Q10.** His overnight work makes him try to sleep by day when light/clock promote wakefulness, so sleep is disrupted; a rotating roster keeps changing the required times so the clock can never entrain to a stable pattern. **Q11.** DSPS: morning light — the SCN suppresses melatonin early, shifting the clock earlier to match the too-late cycle to convention. ASPD: afternoon or evening light — the SCN holds the melatonin rise back, shifting the clock later to match the too-early cycle to convention. **Q12.** Error: evening light is registered by the SCN as a signal to delay melatonin, shifting the clock **later** and worsening DSPS. Correct: use bright light in the **morning** to shift the clock **earlier**. **Q13.** Student B illustrates a circadian rhythm sleep disorder (sleeps normally on a free schedule; timing clashes with school). Student A illustrates sleep deprivation (too little sleep every night regardless of schedule). **Q14.** ASPD; shifted earlier; treat with afternoon or evening bright light (shifts the clock later). **Q15.** (a) IV = whether morning bright light is given (light vs no light); DV = sleep-onset time. (b) Adolescents with DSPS who receive 30 minutes of morning bright light for two weeks will have an earlier sleep-onset time than those who receive no light. (c) e.g. evening screen/light exposure, caffeine, or weekend sleep-ins — any could independently change sleep-onset time. **Q16.** (a) Yes — for DSPS the clock should move earlier, and onset moved from 2:40 am to 12:15 am, about 2 hours 25 minutes earlier. (b) The circadian rhythm shifted earlier (a phase advance). (c) e.g. no control group / small sample (n = 12) / other changes over the three weeks — so causation and generalisability are uncertain. **Q17.** Light during the shift promotes alertness and, via the SCN, helps delay the clock toward the night-work schedule; dark glasses block bright morning light so the SCN does not read it as "day begun" and pull the clock back before daytime sleep. **Q18.** Their sleep amount is normal when the timing is allowed to match their body clock; on work/school days the required hours clash with the shifted clock and cut sleep short, causing exhaustion. **Q19.** In DSPS and ASPD the person's **own internal clock** is shifted (later/earlier); in shift work the clock may be normally timed and it is the **schedule** that is imposed from outside. The worker is still misaligned because the roster requires wakefulness at night and sleep by day, opposite to what a normally timed clock signals — so sleep is short and broken and alertness at work is poor. **Q20.** Model response given in the solutions.

Fully-worked solutions

Q1. (a) A **circadian rhythm sleep disorder** is a persistent **misalignment** between the timing of a person's internal circadian sleep-wake cycle and the timing that their external environment or schedule requires (the sleep itself is typically normal when they follow their own clock). (b) **DSPS** is a disorder in which the sleep-wake cycle is shifted **later** than desired, so the person cannot fall asleep until very late and struggles to wake for morning commitments. (c) **ASPD** is a disorder in which the sleep-wake cycle is shifted **earlier** than desired, so the person feels sleepy in the early evening and wakes very early in the morning.

Q2. (a) Liang most likely has **DSPS**. (b) His sleep-wake cycle is shifted **later** than conventional. (c) When he is free of commitments he follows his own delayed clock, falling asleep near 2 am and sleeping a **full night** until midday, so he wakes refreshed. On school days he must be up at 6:45 am — only part-way through his sleep — so his sleep is **cut short** and he becomes sleep-deprived and drowsy. The problem is the **mismatch** between his late clock and the early wake time, not an inability to sleep.

Q3. (a) Liang should be exposed to bright light in the **morning**. (b) This shifts his circadian clock **earlier** (a phase advance). (c) Bright morning light reaches the SCN, which signals the pineal gland to **suppress melatonin** early; with melatonin falling sooner and the "start of day" cue brought forward, sleep onset and wake time are pulled **earlier**, moving his cycle back toward the conventional schedule.

Q4. (a) Beatrice most likely has **ASPD**. (b) Her sleep-wake cycle is shifted **earlier** than conventional (asleep by 7:30 pm, awake by 4 am). (c) She should use bright light **late in the day — in the afternoon or evening**, which shifts her clock **later** (a phase delay), letting her stay awake later and wake at a more normal hour.

Q5. (a) **Shift work** is working hours that fall **outside the standard daytime pattern** — especially night shifts and rotating rosters. (b) The 11 pm–7 am shift forces workers to be **awake at night**, when the darkness outside and their own circadian rhythm (melatonin high) are both promoting sleep, and to **sleep during the day**, when daylight and the clock are promoting wakefulness — a **misalignment** between the internal clock and the required schedule. (c) Daytime sleep works **against** the circadian drive for wakefulness and against daylight, both of which promote alertness, so it is **shorter and lighter** and less restorative than sleeping at night.

Q6. (a) A **circadian rhythm sleep disorder** is a problem of **timing** — the sleep is misaligned with the schedule but is normal in amount when the person follows their own clock. **Sleep deprivation** is a problem of **amount** — not enough sleep, whenever it is taken. (b) A person with a circadian disorder becomes **sleep-deprived** as a knock-on effect: because their shifted clock clashes with the required schedule, their sleep is repeatedly **cut short**, so they end up with too little sleep. (c) Ask whether they sleep a **normal length and feel rested when free to choose their own hours** — if yes, the problem is timing (a circadian disorder); if they are short of sleep even on a free schedule, it is deprivation.

Q7. In **DSPS** the sleep-wake cycle is shifted **later** than conventional — the person falls asleep and wakes **too late** (e.g. asleep at 3 am, unable to wake in the morning). In **ASPD** the cycle is shifted **earlier** — the person falls asleep and wakes **too early** (e.g. sleepy at 7 pm, awake at 4 am). Both keep a roughly normal sleep length; they differ in the **direction** of the shift.

Q8. Noah has **DSPS**: his sleep-wake cycle is shifted **later** (asleep ~3 am, naturally waking ~11 am, and fine when free to do so). He should use bright light in the **morning**, which shifts his clock **earlier** (a phase advance) so his sleep onset and wake time move back toward a conventional schedule and he can wake for his 8 am classes.

Q9. Colin has **ASPD**: his cycle is shifted **earlier** (asleep by 8 pm, awake at 4 am), so his clock must be moved **later**. Bright light **late in the day — in the afternoon or evening** — produces a **phase delay**: the **SCN** registers the light at that hour and holds back the pineal gland's evening release of **melatonin**, so sleep onset and wake time are pushed later, which is exactly the direction he needs. **Morning** light would be registered by the SCN as the start of the day, suppress melatonin early and shift his clock **earlier**, making the disorder worse — which is why late-day light is the appropriate choice. (Either "afternoon" or "evening" is credited; what matters is that the exposure comes late in his day.)

Q10. Working irregular overnight runs means the driver is awake at night (when his clock and the darkness promote sleep) and tries to sleep in the morning (when daylight and his clock promote wakefulness), so his daytime sleep is short and disrupted — a circadian **misalignment**. A **rotating** roster is harder than a **fixed** one because the required sleep and wake times keep **changing**, so his body clock never has enough time to **entrain** (adjust) to a stable pattern; a fixed roster would at least let the clock partly adapt to one consistent schedule.

Q11. DSPS — give bright light in the **morning**. The **SCN** registers the morning light and signals the pineal gland to **suppress melatonin** early, producing a phase **advance**: sleep onset and waking both move **earlier**, which is the direction a too-**late** DSPS clock must move. **ASPD** — give bright light in the **afternoon or evening**. Light late in the day is registered by the **SCN**, which **holds back** the pineal gland's evening melatonin rise, producing a phase **delay**: sleep onset and waking both move **later**, which is the direction a too-**early** ASPD clock must move. In each case the clock is nudged **toward** the time of day the light is given.

Q12. The plan is **wrong in its timing**. Light in the evening is registered by the **SCN** as a signal to **delay** the release of melatonin, producing a phase **delay** that shifts the clock **later** — the **opposite** of what DSPS needs, and it would make the disorder **worse** (an even later sleep onset). To treat DSPS the clock must move **earlier**, so the student should use bright light in the **morning**, soon after waking, so the SCN suppresses melatonin early and produces a phase **advance**.

Q13. Student B best illustrates a **circadian rhythm sleep disorder**: on a free schedule (weekends) she sleeps a normal 8 hours (2 am–10 am) and feels fine, so her sleep amount is normal — the problem is that her **late-shifted timing** clashes with the school wake time, cutting her school-night sleep to 5 hours (consistent with DSPS). **Student A** illustrates **sleep deprivation**: he gets only 5 hours **every** night regardless of the day, because he delays sleep by scrolling — the problem is **insufficient sleep**, not misaligned timing.

Q14. The client has **ASPD**: sleepy by 6:30 pm and waking at 3 am, with a **normal-length** sleep when measured, so the cycle is shifted **earlier**. To move the clock **later**, treat with bright light **late in the day (afternoon or evening)**: the **SCN** registers it and holds back the evening melatonin rise, producing a phase **delay** that carries the whole cycle later, toward a conventional schedule.

Q15. (a) The **independent variable** is whether morning bright light is given (bright light vs no light); the **dependent variable** is the participants' **sleep-onset time**. (b) *Hypothesis:* adolescents diagnosed with DSPS who receive 30 minutes of morning bright light (10 000 lux) each morning for two weeks will have an **earlier** sleep-onset time than adolescents with DSPS who receive no light. (c) One **extraneous variable** is **evening light/screen exposure** (or caffeine, or weekend sleep-ins): for example, heavy phone use at night suppresses melatonin and delays sleep onset, which could **counteract or exaggerate** the effect of the morning light and be mistaken for the treatment's effect, so it should be controlled/held constant across groups.

Q16. (a) **Yes.** For DSPS the clock needs to move **earlier**, and the mean sleep-onset time moved from **2:40 am to 12:15 am** — about **2 hours 25 minutes earlier** — which is the intended direction. (b) An earlier sleep-onset time means the circadian rhythm shifted **earlier** (a phase **advance**), consistent with the effect of **morning** light. (c) The clinic should be cautious because there is **no control group** and the sample is **small (n = 12)**: other factors over the three weeks (changed routine, expectation/placebo, seasonal daylight) could explain the shift, so it cannot confidently conclude the therapy **caused** the change, nor generalise the result to all DSPS patients.

Q17. Bright light during the shift is registered by her **SCN**, which **suppresses melatonin** while she is at work: this promotes **alertness** on shift and, because the light is arriving in her "late" hours, **delays** her body clock toward her night-work schedule. **Dark glasses on the morning drive home** stop bright morning light reaching the SCN, where it would otherwise be read as the start of the day, suppress melatonin and shift her clock **earlier** (a phase advance), dragging it back toward a daytime schedule; blocking it protects the delay achieved and lets her fall asleep more easily once home. Together they help her clock **align** with night work.

Q18. In a circadian rhythm sleep disorder the **amount** of sleep is normal — the person sleeps a full, restful night **when the timing is allowed to match their body clock** (for example on holidays or weekends). On work or school days, however, the **required** sleep and wake times clash with their **shifted** clock, so their sleep is **cut short** (they cannot fall asleep early enough, or they wake too early), leaving them sleep-deprived and exhausted. The exhaustion comes from the **mismatch in timing**, not from an inability to sleep.

Q19. In **DSPS** and **ASPD** the change is **internal**: the person's own circadian clock is set to the wrong time relative to convention — **later** in DSPS, **earlier** in ASPD — and if they are left to follow it they sleep a normal length and feel rested. In **shift work** the change is **externally imposed**: the roster dictates when the person must be awake and asleep, and the clock itself may be perfectly normally timed. The cause of the misalignment therefore sits in the **body clock** in DSPS and ASPD, but in the **schedule** in shift work.

A night-shift worker with a normally timed clock still develops a circadian rhythm sleep disorder because misalignment only requires the **clock and the required schedule to disagree** — it does not matter which of the two has moved. Their normally timed clock is signalling **sleep** through the night (melatonin is high and the darkness reinforces it) at exactly the hours the roster requires **alertness**, and is signalling **wakefulness** through the day (melatonin low, daylight reaching the SCN) at exactly the hours the roster leaves for **sleep**. The result is the same misalignment seen in DSPS and ASPD: daytime sleep that is **short and light**, sleepiness and impaired concentration on shift, and knock-on sleep deprivation.

Q20. *Model response (6 marks).* **Bright light therapy** works through the pathway that entrains the circadian rhythm. Bright light entering the eye is detected by the **retina** and **registered by the suprachiasmatic nucleus (SCN)**, the master clock in the hypothalamus. The SCN then signals the **pineal gland**, changing the **timing of melatonin release**

— and because melatonin is the hormone that promotes sleep, changing when it rises and falls changes when sleep onset and waking occur. Crucially, the **direction** of the shift depends on **when in the person's day** the light arrives: light early in their day advances the clock, light late in their day delays it.

For **DSPS**, the clock is set **too late**, so it must move **earlier**. Bright light is given in the **morning**, soon after waking: the SCN registers it as the start of the day and **suppresses melatonin early**. The result is a **phase advance** — both sleep onset and waking move **earlier**, back toward the school or work schedule.

For **ASPD**, the clock is set **too early**, so it must move **later**. Bright light is given **late in the day — in the afternoon or evening**: the SCN registers light at an hour when this person's clock has already begun signalling sleep, and **holds the melatonin rise back**. The result is a **phase delay** — both sleep onset and waking move **later**.

For a **permanent night-shift worker** the clock is not itself abnormal — it is the roster that is misaligned — so the same mechanism is used to **drag the clock around to match the roster** rather than back to convention. Bright light is given **during the night shift**: the SCN registers it, suppresses melatonin at work and delays the clock toward the night-work pattern, which also keeps the worker alert. Just as importantly, bright **morning** light must be **avoided** on the way home (for example by wearing dark glasses), because the SCN would read it as the start of the day, advance the clock and undo the delay before daytime sleep.

In every case the clock is nudged **toward** the time of day the light is given; only the direction the clock needs to move differs. *(Full marks require: the mechanism stated as light → SCN → change in the pineal gland's melatonin release — the SCN must be named, not melatonin alone; morning light and a phase advance for DSPS; afternoon or evening light and a phase delay for ASPD; and, for the night-shift worker, light during the shift plus avoidance of morning light to hold the delay.)*

Chapter 8 Importance of sleep to mental wellbeing — 8C Sleep hygiene and zeitgebers

Theory

Sleep hygiene is the set of **habits and practices that promote good, regular sleep**. Good sleep hygiene keeps the sleep-wake cycle running smoothly; poor sleep hygiene works against it, making sleep harder to obtain and lower in quality. Sleep hygiene matters because sleep is essential to mental wellbeing — regular, good-quality sleep supports mood, concentration and emotional regulation, whereas disrupted sleep places wellbeing under strain.

The body clock has to be reset each day. The sleep-wake cycle is a **circadian rhythm** — a biological rhythm with a period of about 24 hours — coordinated by an internal master clock, the **suprachiasmatic nucleus (SCN)** in the hypothalamus, which controls the release of the sleep hormone **melatonin** from the pineal gland. Left entirely to itself the human body clock actually runs a little *longer* than 24 hours, so each day it must be nudged back into step with the 24-hour day. The external cues that do this daily resetting are called zeitgebers. (The internal SCN–melatonin mechanism is covered in Chapter 7; here the focus is on the external cues that *set* the clock and on the habits that support sleep.)

Zeitgebers. A **zeitgeber** (German for "time-giver") is an **external cue that helps entrain (set) the circadian rhythm**. It is important to keep the two sides apart: a zeitgeber is *external* to the body (light, temperature, the timing of meals), whereas the SCN and melatonin are the *internal* mechanism that the zeitgeber acts on. Adjusting our exposure to zeitgebers is therefore a practical way to shift and steady the sleep-wake cycle. The study design names three.

1. Daylight and blue light — the most powerful zeitgeber. Light is the strongest cue for the body clock, because the SCN is set directly by light detected by the eyes.

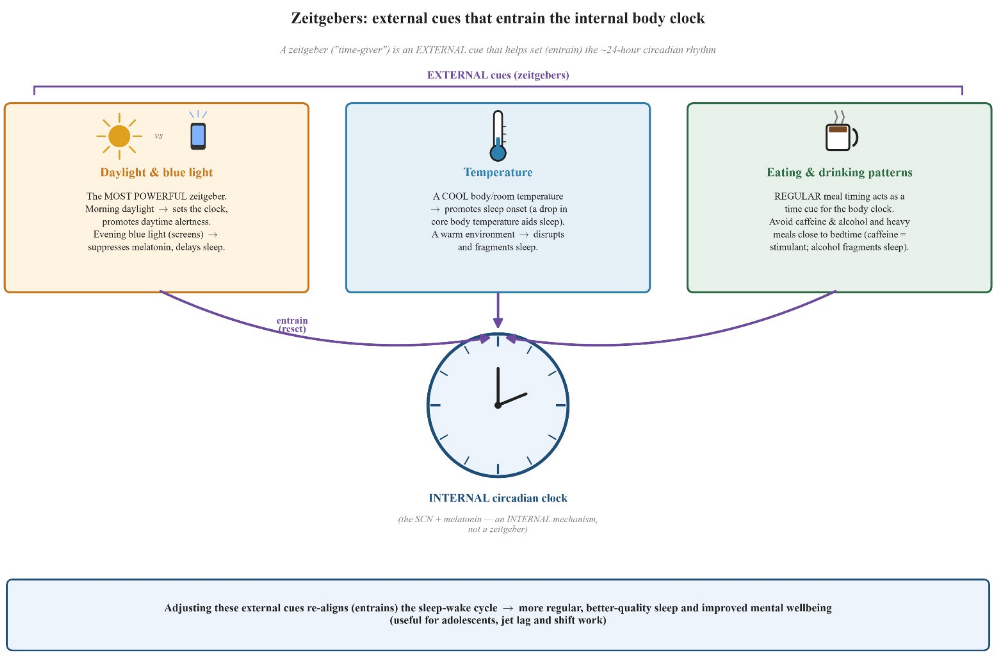
- **Morning daylight** helps *set the clock* to the start of the day and promotes daytime alertness. Getting bright light soon after waking signals "day" to the SCN and helps anchor the sleep-wake cycle.
- **Evening blue light** — the short-wavelength light of screens and devices — does the opposite: it **suppresses melatonin**, so the body is told it is still daytime, and **sleep onset is delayed**. This is why device use late at night pushes the sleep-wake cycle later.
- The practical rule: seek bright (ideally natural) light in the **morning**, and reduce screens and bright light in the **evening**.

2. Temperature. Body and room temperature act as a cue for sleep.

- A **cool** body and room temperature *promotes sleep onset*. Falling asleep is associated with a **drop in core body temperature**; a cool room helps the body shed heat, which supports this fall and helps sleep begin.
- A **warm** environment does the opposite — it makes it harder to lose heat, so sleep onset is delayed and sleep is more easily disrupted through the night.
- The practical rule: keep the bedroom on the **cool** side.

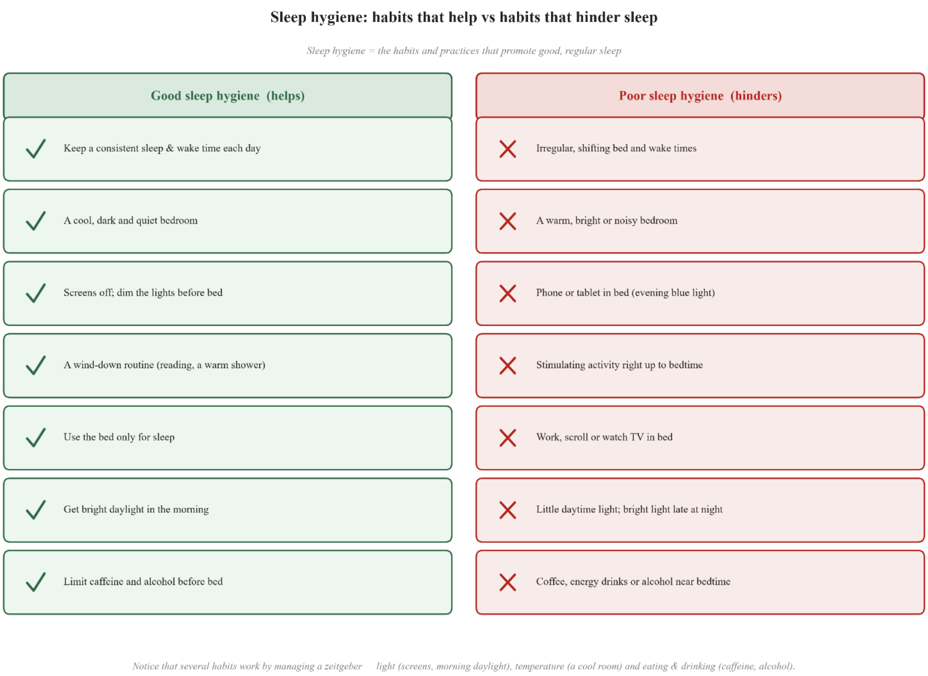
3. Eating and drinking patterns. *When* we eat and drink is also a time cue.

- **Regular meal timing** helps act as a zeitgeber, giving the body a predictable daily pattern that supports the sleep-wake cycle.
- **Caffeine** (in coffee, tea, cola and energy drinks) is a **stimulant** — it increases alertness and, taken in the afternoon or evening, delays sleep onset and reduces sleep.
- **Alcohol**, although it can make a person feel drowsy at first, **fragments sleep** later in the night, producing more awakenings and poorer-quality sleep.
- A large, heavy meal close to bedtime can also disrupt sleep.
- The practical rule: keep meal times regular, and avoid caffeine, alcohol and heavy meals close to bedtime.



Putting it into practice — sleep hygiene. Good sleep hygiene applies these ideas as everyday habits:

- keep a **consistent sleep and wake time**, every day (including weekends), so the sleep-wake cycle stays anchored;
- make the bedroom **cool, dark and quiet** (managing the temperature and light cues);
- **avoid screens and bright light before bed**, and get **bright daylight in the morning** (managing the light zeitgeber);
- follow a relaxing **wind-down routine** (for example reading or a warm shower) before bed;
- **use the bed only for sleep**, so the bed becomes a strong cue for sleeping rather than for scrolling, working or watching TV;
- **limit caffeine and alcohol**, especially in the hours before bed.



Why this improves wellbeing. Adjusting zeitgebers and sleep hygiene re-aligns the sleep-wake cycle so that a person feels sleepy at an appropriate time and sleeps well, which in turn supports mental wellbeing. The approach is especially useful when the sleep-wake cycle is out of step with the day, for example:

- **adolescents**, whose body clock naturally tends to run late — reducing evening screen light, getting morning daylight and keeping a regular schedule help pull the cycle earlier;
- **jet lag**, after flying across time zones — seeking daylight at the right time of day at the destination, and shifting meal times to local time, help the body clock re-entrain to the new zone;
- **shift work**, where a person must sleep during the day — a cool, dark, quiet room, limiting light and caffeine before day-sleep, and keeping a consistent schedule help protect sleep.

Key points to keep straight (common exam traps).

- **Light:** *morning* daylight sets/advances the clock and promotes alertness; *evening* blue light **suppresses melatonin** and **delays** sleep. Do not mix these up.
- **Temperature:** a **cool** temperature aids sleep onset (linked to a drop in core body temperature); a *warm* room hinders it. (Students often wrongly say warmth helps.)
- **Eating and drinking:** caffeine is a **stimulant** that delays sleep; alcohol **fragments** sleep even though it can feel sedating at first; keep meal times regular.
- **Zeitgeber vs internal mechanism:** a zeitgeber is an **external cue** (light, temperature, meal timing). The **SCN and melatonin** are the **internal** mechanism the zeitgeber acts on — they are *not* zeitgebers.

How to analyse a scenario. (1) Identify what in the scenario is acting as a **zeitgeber** (light/screens, temperature, or meal/drink timing), or which **sleep-hygiene** habit is good or poor. (2) State the *direction* of the effect (does it set the clock and aid sleep, or delay/disrupt it?) and, where relevant, the mechanism (e.g. blue light → suppresses melatonin → delayed sleep onset). (3) Recommend the adjustment and link it back to a **better-aligned sleep-wake cycle** and improved wellbeing.

Worked examples

Example 1 — scaffolded

Mia, 16, scrolls on her phone in bed until about 1 am most nights. She finds she cannot fall asleep and is exhausted at school. Identify the zeitgeber involved, explain how it is affecting her sleep, and recommend one sleep-hygiene change.

Working	Comment
The **light** from Mia's phone is the zeitgeber — specifically **evening blue light**.	First identify which of the three zeitgebers the scenario involves.
Blue light in the evening **suppresses melatonin**, so her body is signalled that it is still daytime and **sleep onset is delayed**.	State the direction and the mechanism (blue light → less melatonin → later sleep).
Because she falls asleep late but must still wake for school, her sleep-wake cycle is pushed later and she becomes sleep-deprived, hence the daytime tiredness.	Link the disrupted cue to a mis-aligned sleep-wake cycle.
Recommend: stop screen use about an hour before bed and dim the lights (and get bright daylight in the morning).	Give a concrete sleep-hygiene change that manages the light zeitgeber.

Example 2 — scaffolded

Sam flies from Melbourne to London (about a 9-hour time difference) and finds his sleep-wake cycle is out of step with local time. Explain how Sam could use two zeitgebers to help his body clock re-entrain to London time.

Working	Comment
Sam's internal clock is still set to Melbourne time, so it is out of step with the London day — this is jet lag.	Frame the problem as a mis-aligned circadian rhythm.
Light: get **bright daylight** during the London day (e.g. spend time outdoors in daytime) and avoid bright	Light is the most powerful zeitgeber for re-setting the clock.

Working	Comment
light during the London night.	
Eating and drinking: shift meal times to the **local London meal times** to give the body a consistent daily time cue.	Regular meal timing acts as a second zeitgeber.
Over several days these cues **entrain** his clock to London time, re-aligning his sleep-wake cycle.	Conclude by linking the adjusted cues to re-entrainment.

Example 3 — unscaffolded

A night-shift worker sleeps during the day. Her bedroom is warm and sunlit, and she drinks two coffees at the end of her shift on the way home. Identify the three zeitgebers that are working against her daytime sleep and explain one adjustment she could make for each.

Three zeitgebers are working against her. First, **light**: her room is **sunlit**, and daylight is the most powerful zeitgeber, signalling "day" and suppressing melatonin, so she should **block out the light** (heavy curtains or an eye mask) to help her body treat the daytime as night. Second, **temperature**: her room is **warm**, but a **cool** room promotes sleep onset because falling asleep is associated with a **drop in core body temperature**, so she should **cool the room**. Third, **eating and drinking**: the coffee is a **stimulant** that will increase her alertness and delay her sleep, so she should **avoid caffeine** at the end of her shift. ∴ by darkening and cooling the room and avoiding late caffeine, she manages all three external cues so that her sleep-wake cycle better supports daytime sleep.

Example 4 — unscaffolded

A student writes: "To sleep well you should have a warm bedroom and a big supper right before bed, and it doesn't matter what time you go to sleep as long as you get enough hours." Evaluate this claim with reference to zeitgebers and sleep hygiene.

The claim is **largely incorrect**. A **warm** bedroom does not help; a **cool** room promotes sleep onset because falling asleep is associated with a **drop in core body temperature**, so a warm room actually hinders sleep. A **big supper right before bed** is also poor sleep hygiene — a heavy meal close to bedtime can disrupt sleep, and irregular late eating weakens the meal-timing cue. Finally, the *time* of sleep does matter: keeping a **consistent** sleep and wake time is a key sleep-hygiene habit that keeps the sleep-wake cycle anchored, so "any time is fine" is wrong even if the number of hours is adequate. ∴ good sleep depends on a cool bedroom, sensible meal timing and a regular schedule — not on warmth, a large late meal or an arbitrary bedtime.

Practice questions

Scaffolded

Q1. Define each of the following: (a) sleep hygiene; (b) zeitgeber; (c) what it means to say the body clock is *entrained* by a zeitgeber.

Q2. State two sleep-hygiene practices relating to each of the following: (a) the sleep environment; (b) light and screens; (c) eating and drinking.

Q3. Liam checks social media on his phone in bed each night. (a) Identify which zeitgeber this involves. (b) Explain the effect of evening blue light on melatonin and on sleep onset. (c) State one change Liam could make and explain how it helps.

Q4. Consider room and body temperature as a zeitgeber. (a) State the temperature condition that promotes sleep onset. (b) Explain why, referring to core body temperature. (c) Describe one sleep-hygiene practice that uses temperature.

Q5. Consider eating and drinking patterns. (a) Explain how regular meal timing can act as a zeitgeber. (b) Explain why caffeine in the evening disrupts sleep. (c) Explain why alcohol harms sleep quality even though it can make a person feel drowsy.

Q6. A zeitgeber and the body's internal clock are different things. (a) Define a zeitgeber. (b) Name the internal master clock and the hormone it controls. (c) Explain the difference between a zeitgeber and the SCN.

Unscaffolded

Q7. Distinguish between a zeitgeber and an internal mechanism that regulates the sleep-wake cycle. *(2 marks)*

Q8. Explain why light is described as the most powerful zeitgeber. *(2 marks)*

Q9. Priya plays video games on a bright screen until midnight, then lies awake for over an hour before falling asleep. Apply your knowledge of zeitgebers to explain why she cannot fall asleep, and recommend one change. *(3 marks)*

Q10. Explain how keeping a bedroom cool promotes sleep onset. Refer to core body temperature in your answer. *(3 marks)*

Q11. A student claims that a warm bedroom and a large hot meal just before bed both help you fall asleep. Identify and correct the error in each claim. *(2 marks)*

Q12. Explain how caffeine and alcohol each affect sleep, and explain why the *timing* of consuming them matters. *(3 marks)*

Q13. After flying from Melbourne to Los Angeles, Tomas feels wide awake at night and exhausted during the day. Apply two zeitgebers that Tomas could use to help his body clock re-align to Los Angeles time, and explain how each works. *(4 marks)*

Q14. Explain how getting bright daylight in the morning and avoiding bright light in the evening work *together* to keep the sleep-wake cycle aligned. *(3 marks)*

Q15. Distinguish between good and poor sleep hygiene, using one example related to light and one related to the sleep environment. *(3 marks)*

Q16. *Research scenario.* A psychologist investigates whether wearing blue-light-blocking glasses in the two hours before bed reduces the time taken to fall asleep (sleep-onset latency). Forty adults are randomly allocated to wear either blue-light-blocking glasses or clear glasses each evening for a week; the mean sleep-onset latency of each group is then recorded.

Group	Mean sleep-onset latency (minutes)	SD
Blue-light-blocking glasses	18.4	5.1
Clear glasses (control)	27.9	6.3

(a) Identify the independent variable and the dependent variable.
(b) Write a directional (one-tailed) hypothesis for this investigation that names both levels of the IV and the direction of the DV.
(c) With reference to the data, state a conclusion. *(5 marks)*

Q17. *Research scenario.* A sleep researcher compares two groups of shift workers: one group is coached to keep a **consistent** sleep and wake schedule, the other keeps its usual **variable** schedule. After four weeks, each participant's sleep quality is rated out of 100 (higher = better).

Group	Mean sleep-quality score	SD
Consistent schedule	71.2	8.0
Variable schedule	58.6	9.4

(a) Identify the experimental design used (within-subjects, between-subjects or mixed) and justify your answer.
(b) Identify one extraneous variable that should be controlled, and explain how it could affect the results.
(c) State a conclusion for this study, and then state one implication of the findings. *(5 marks)*

Q18. Explain how improving sleep through zeitgebers and sleep hygiene can support a person's *mental wellbeing*. *(3 marks)*

Q19. Adolescents often have a body clock that naturally runs late, so they feel awake late at night and struggle to wake for school. Recommend three changes an adolescent could make — one involving light, one involving the sleep environment, and one involving a consistent schedule — and justify each. *(4 marks)*

Q20. *Extended response.* Dev, a Year 12 student, goes to bed at a different time each night, studies on a bright laptop in bed until he feels sleepy, keeps his room warm, and drinks cola in the evening. He sleeps poorly and feels flat and unfocused. Using **sleep hygiene** and at least **two zeitgebers**, explain how Dev could re-align his sleep-wake cycle, and justify why this would improve his mental wellbeing. In your answer, distinguish a zeitgeber from an internal mechanism. *(6 marks)*

Answers

Q1. (a) The habits and practices that promote good, regular sleep. (b) An external cue that helps entrain (set) the circadian rhythm. (c) The zeitgeber resets the ~24-hour body clock each day so it stays in step with the day-night cycle. **Q2.** (a) e.g. a cool room; a dark/quiet room. (b) e.g. no screens before bed; bright daylight in the morning. (c) e.g. regular meal times; avoid caffeine/alcohol before bed. **Q3.** (a) Light (evening blue light). (b) Blue light suppresses melatonin, so sleep onset is delayed. (c) e.g. stop screens about an hour before bed → melatonin rises normally → falls asleep sooner. **Q4.** (a) Cool. (b) Sleep onset is associated with a drop in core body temperature; a cool room helps the body lose heat. (c) e.g. keep the bedroom cool / use lighter bedding. **Q5.** (a) Regular meal times give the body a predictable daily time cue. (b) Caffeine is a stimulant that increases alertness and delays sleep onset. (c) Alcohol fragments sleep later in the night (more awakenings, poorer quality) despite the initial drowsiness. **Q6.** (a) An external cue that entrains the circadian rhythm. (b) The SCN; melatonin. (c) The zeitgeber is an external cue; the SCN is the internal master clock the cue acts on. **Q7.** A zeitgeber is an external cue (e.g. light); the internal mechanism (the SCN and melatonin) is inside the body and is set by the zeitgeber. **Q8.** The SCN is set directly by light detected by the eyes, so light most strongly resets the clock (and suppresses melatonin). **Q9.** Bright evening screen light suppresses melatonin, delaying sleep onset; change = stop screens before bed / dim the lights (and get morning daylight). **Q10.** A cool room helps the body shed heat and lower core body temperature, which is associated with sleep onset, so sleep begins more easily. **Q11.** "Warm" is wrong — a **cool** room aids sleep (core-temperature drop). "Large meal before bed" is wrong — a heavy late meal disrupts sleep. **Q12.** Caffeine = stimulant → delays sleep; alcohol → fragments sleep. Timing matters because their effects near bedtime disrupt sleep onset and quality. **Q13.** e.g. Light: get daytime outdoor light in Los Angeles and avoid light at LA night. Meal timing: shift meals to LA times. Each gives a time cue that re-entrains the clock. **Q14.** Morning daylight sets/advances the clock and promotes alertness; avoiding evening light lets melatonin rise on time — together they anchor the cycle to the 24-hour day. **Q15.** Good = e.g. morning daylight + a dark room; poor = e.g. evening screens + a bright/warm room (a two-sided contrast with a light example and an environment example). **Q16.** (a) IV = type of glasses (blue-light-blocking vs clear); DV = sleep-onset latency (minutes). (b) Directional hypothesis — see solutions. (c) The blue-light-blocking group fell asleep faster (18.4 vs 27.9 min), supporting the hypothesis. **Q17.** (a) Between-subjects design (two separate groups, each in one condition). (b) e.g. caffeine intake / shift type — could affect sleep quality independently of schedule. (c) Conclusion vs implication — see solutions. **Q18.** Better-aligned, good-quality sleep supports mood, concentration and emotional regulation, which protects and improves mental wellbeing. **Q19.** Light: morning daylight and no evening screens; environment: a cool, dark, quiet room; schedule: a consistent sleep and wake time — each helps pull/anchor the delayed clock earlier. **Q20.** Model response given in the solutions.

Fully-worked solutions

Q1. (a) **Sleep hygiene** is the set of **habits and practices that promote good, regular sleep** (for example a consistent schedule and a cool, dark bedroom). (b) A **zeitgeber** is an **external cue that helps entrain (set) the circadian rhythm** — light, temperature and meal timing are examples. (c) To say the clock is **entrained** by a zeitgeber means the external cue **resets the ~24-hour body clock each day** so that it stays in step with the day-night cycle (the clock would otherwise drift, because it runs slightly longer than 24 hours).

Q2. (a) *Sleep environment:* keep the bedroom **cool**, and keep it **dark and quiet**. (b) *Light and screens:* **avoid screens/bright light before bed**, and get **bright daylight in the morning**. (c) *Eating and drinking:* keep **regular meal times**, and **avoid caffeine and alcohol** (and heavy meals) close to bedtime.

Q3. (a) The zeitgeber is **light** — specifically the **evening blue light** from Liam's phone. (b) Blue light in the evening **suppresses melatonin**, the sleep hormone; with melatonin held back the body is signalled that it is still daytime, so **sleep onset is delayed**. (c) Liam could **stop using his phone about an hour before bed** (and dim the lights). With no blue light suppressing it, melatonin can rise normally in the evening, so he feels sleepy and falls asleep sooner.

Q4. (a) A **cool** body and room temperature promotes sleep onset. (b) Falling asleep is associated with a **drop in core body temperature**; a **cool** room helps the body **lose heat** and lower its core temperature, which supports the onset of sleep. (A warm room prevents this heat loss and delays sleep.) (c) A suitable sleep-hygiene practice is to **keep the bedroom cool** (for example by lowering the temperature or using lighter bedding) before sleeping.

Q5. (a) Eating at **regular times** gives the body a **predictable daily time cue**, which helps keep the sleep-wake cycle in step — meal timing therefore acts as a zeitgeber. (b) **Caffeine** is a **stimulant**: it increases alertness, so caffeine consumed in the evening **delays sleep onset** and reduces sleep. (c) **Alcohol** can make a person feel drowsy at first, but it **fragments sleep** later in the night, causing more awakenings and poorer-quality sleep, so overall it harms sleep quality.

Q6. (a) A **zeitgeber** is an **external cue** that helps entrain (set) the circadian rhythm. (b) The internal master clock is the **suprachiasmatic nucleus (SCN)**; the hormone it controls the timing of is **melatonin**. (c) A zeitgeber is an **external** cue (such as light) coming from the environment; the **SCN** is the **internal** master clock inside the brain that the zeitgeber acts on to reset. In short, the zeitgeber is the cue and the SCN is the mechanism being set — they are not the same thing.

Q7. A **zeitgeber** is an **external cue** in the environment — such as light, temperature or meal timing — that helps set the sleep-wake cycle. An **internal mechanism** — such as the **SCN** and the hormone **melatonin** — is *inside* the body and is what actually keeps the circadian rhythm; the zeitgeber works by **setting (entraining)** this internal mechanism. One is the external cue; the other is the internal clock it adjusts.

Q8. Light is the **most powerful zeitgeber** because the **SCN is set directly by light** detected by the eyes (the retina). Light therefore has the strongest influence on the timing of the clock and on melatonin release — bright light suppresses melatonin and signals "day", while darkness allows melatonin to rise — so managing light exposure shifts the sleep-wake cycle more effectively than any other cue.

Q9. The **bright screen light** in the evening is acting as a **light zeitgeber**. Late-evening blue light **suppresses melatonin**, so Priya's body is signalled that it is still daytime and her **sleep onset is delayed** — which is why she lies awake for over an hour. A useful change is to **stop gaming and switch off bright screens well before bed** (and dim the room lights); melatonin can then rise normally and she should fall asleep sooner.

Q10. Sleep onset is associated with a **drop in core body temperature**. Keeping the bedroom **cool** helps the body **lose heat** to the environment, which lowers core body temperature; because this fall in temperature is linked to the onset of sleep, a cool room helps sleep begin more quickly. (A warm room prevents heat loss, keeps core temperature up, and so delays sleep.)

Q11. *Warm bedroom:* this is **incorrect** — a **cool** bedroom promotes sleep onset, because falling asleep is associated with a **drop in core body temperature**; a warm room hinders sleep. *Large hot meal just before bed:* this is also **incorrect** — a **heavy meal close to bedtime disrupts sleep**, and eating late weakens the regular meal-timing cue; a lighter meal earlier in the evening is better.

Q12. Caffeine is a **stimulant** that increases alertness, so it **delays sleep onset** and reduces sleep. **Alcohol** can bring on drowsiness at first but **fragments sleep** later in the night, producing more awakenings and poorer-quality sleep. **Timing** matters because both substances have their strongest disruptive effect when consumed **close to bedtime** — caffeine taken in the afternoon or evening is still active at bedtime, and alcohol in the evening disrupts the later part of the night — so both are best avoided in the hours before sleep.

Q13. Tomas has **jet lag**: his body clock is still set to Melbourne time and is out of step with Los Angeles time. **Zeitgeber 1 — light:** he should get **bright daylight during the LA day** (e.g. spend time outdoors in daylight) and **avoid bright light during the LA night**; because light is the most powerful cue, this helps reset the SCN to the new time zone. **Zeitgeber 2 — eating and drinking:** he should **shift his meals to local Los Angeles meal times**, giving his body a consistent daily time cue. Over several days these two cues **entrain** his clock to LA time and re-align his sleep-wake cycle.

Q14. The two work **together** as opposite halves of the light cue. **Morning bright daylight** sets (advances) the clock to the start of the day and promotes daytime alertness by signalling "day" to the SCN. **Avoiding bright light in the evening** allows **melatonin to rise on time**, signalling "night" and bringing on sleepiness at the right hour. Getting light at the right time in the morning and removing it at night therefore anchors the sleep-wake cycle firmly to the 24-hour day, so the person wakes and sleeps at consistent, appropriate times.

Q15. Good sleep hygiene consists of habits that support sleep, whereas **poor sleep hygiene** consists of habits that work against it. *Light example:* getting **bright daylight in the morning** and keeping screens off before bed is good hygiene, whereas **using bright screens late at night** (evening blue light) is poor hygiene because it suppresses melatonin and delays sleep. *Sleep-environment example:* a **cool, dark, quiet bedroom** is good hygiene, whereas a **warm, bright or noisy bedroom** is poor hygiene because it makes sleep harder to obtain and to maintain. (Both sides are contrasted, congruently.)

Q16. (a) The **independent variable (IV)** is the **type of glasses worn** in the two hours before bed (blue-light-blocking vs clear/control); the **dependent variable (DV)** is the **sleep-onset latency** (the time taken to fall asleep, in minutes). (b) A suitable **directional hypothesis** is: *"It is hypothesised that adults who wear blue-light-blocking glasses in the two hours before bed will have a shorter mean sleep-onset latency than adults who wear clear glasses."* (This names both levels of the IV and gives the direction of the DV.) (c) **Conclusion:** the group wearing blue-light-blocking glasses had a **lower mean sleep-onset latency (18.4 minutes) than the clear-glasses control group (27.9 minutes)** — a difference of about 9.5 minutes — so the results **support the hypothesis** that reducing evening blue light shortens the time taken to fall asleep (for this sample of adults).

Q17. (a) The design is **between-subjects** (also called independent groups): there are **two separate groups** of participants, one in the consistent-schedule condition and one in the variable-schedule condition, and each participant experiences **only one** condition. It is *not* within-subjects, because no participant completes both conditions, and *not* mixed, because sleep quality is measured at **only one** time point (after four weeks) rather than more than once. (b) An **extraneous variable** to control is, for example, the participants' **caffeine intake** (or their type/hours of shift work): if one group happened to consume less caffeine, that could **improve their sleep quality independently of the schedule**, confounding the results; it should be controlled (e.g. by **randomly allocating** participants to the two groups, and by keeping caffeine intake similar across both groups). (c) **Conclusion:** keeping a **consistent** sleep and wake schedule was associated with **higher sleep-quality scores** (mean 71.2) than a variable schedule (mean 58.6) for these shift workers, supporting the idea that a regular schedule improves sleep quality. **Implication:** more broadly, this suggests that **shift workers (and others) could be advised to keep regular sleep-wake times** to improve their sleep — the conclusion describes what this study found, whereas the implication applies that finding to real-world practice.

Q18. Sleep is essential to mental wellbeing, so re-aligning the sleep-wake cycle through zeitgebers and sleep hygiene improves wellbeing in a chain: managing light, temperature and meal timing (and keeping good sleep habits) helps a person **fall asleep at an appropriate time and get good-quality, sufficient sleep**; adequate sleep in turn **supports mood, concentration and emotional regulation**. By reducing the strain that disrupted or insufficient sleep places on a person, better sleep **protects and improves mental wellbeing**.

Q19. *Light:* get **bright daylight in the morning** and **avoid screens/bright light in the evening** — morning light advances the clock while removing evening blue light lets melatonin rise on time, helping pull the delayed cycle earlier. *Sleep environment:* keep the bedroom **cool, dark and quiet** — a cool, dark room supports the drop in core body temperature and the melatonin rise needed for sleep onset. *Consistent schedule:* keep the **same sleep and wake time every day** (including weekends) — a regular schedule anchors the sleep-wake cycle so the body clock stops drifting later. Together these adjust the key zeitgebers and habits to counter the adolescent's naturally delayed clock.

Q20. *Model response (6 marks).* Dev's habits are working against his sleep-wake cycle, and several zeitgebers and sleep-hygiene rules can fix them. **Light (zeitgeber 1):** studying on a **bright laptop in bed** exposes him to **evening blue light, which suppresses melatonin and delays sleep onset**; he should stop screen work well before bed, dim the lights, and get **bright daylight in the morning** to help set his clock. **Temperature (zeitgeber 2):** his **warm** room hinders sleep, because sleep onset is associated with a **drop in core body temperature**, so he should keep the bedroom **cool**. **Eating and drinking (a further zeitgeber/sleep-hygiene fix):** the **cola** contains **caffeine, a stimulant** that delays sleep, so he should avoid it in the evening. He should also adopt core sleep-hygiene habits: a **consistent sleep and wake time**, and using the **bed only for sleep** (not for studying). Importantly, these zeitgebers are **external cues** — Dev is adjusting light, temperature and what he drinks; they work by **entraining his internal clock** (the **SCN** and its hormone **melatonin**), which is the internal mechanism, not a zeitgeber. By re-aligning his sleep-wake cycle he should fall asleep more easily and sleep better, and because good sleep **supports mood, concentration and emotional regulation**, this would improve his mental wellbeing — he should feel less flat and more focused. *(Full marks require: use of sleep-hygiene practices; at least two named zeitgebers with correct directional effects; an explicit zeitgeber-vs-internal-mechanism distinction; and a justified link from better sleep to improved mental wellbeing.)*

Topic 4 Test A — Multiple choice

Reading time: 5 minutes. Writing time: 25 minutes. 20 questions, 20 marks. No calculator, no notes. Choose the response that is correct or that best answers the question. A correct answer scores 1 mark; an incorrect answer scores 0. Marks are not deducted for incorrect answers.

Question 1

A psychologist explains that sleep itself cannot be directly seen or measured; instead, we conclude that a person is asleep by inferring it from consistent physiological and behavioural signs. This is the reason sleep is best described as:

A. a state of complete unconsciousness

B. a subjective measure of sleep

C. a psychological construct

D. an objective physiological measure

Question 2

A recording made at 4 am shows fast, low-amplitude brain waves much like those of an alert person, bursts of movement beneath the closed eyelids, and almost no activity in the voluntary muscles. This period of sleep is:

A. NREM Stage 1

B. NREM Stage 3

C. normal waking consciousness

D. REM sleep

Question 3

Which of the following is true of NREM Stage 3 sleep?

A. It is the deepest, most physically restorative stage of sleep.

B. It is the stage from which a sleeper is most easily woken.

C. It shows brain-wave activity almost identical to that of the awake brain.

D. It is the stage in which the voluntary muscles are paralysed (atonia).

Question 4

A sleep researcher wants to detect the bursts of rapid eye movement that help to confirm REM sleep. The most appropriate measure is:

A. the electromyograph (EMG)

B. the electro-oculograph (EOG)

C. video monitoring of the sleeper

D. the electroencephalograph (EEG)

Question 5

As a person moves from being awake and alert into progressively deeper sleep, the electroencephalograph (EEG) trace shows brain waves that:

A. decrease in frequency and increase in amplitude

B. increase in frequency and decrease in amplitude

C. decrease in both frequency and amplitude

D. increase in both frequency and amplitude

Question 6

A sleep diary is best classified as:

A. an objective physiological measure

B. an objective behavioural measure

C. a direct recording of brain-wave activity

D. a subjective self-report measure

Question 7

The sleep cycle, which lasts about 90 minutes and repeats four to five times each night, is an example of:

A. a circadian rhythm

B. an ultradian rhythm

C. the suprachiasmatic nucleus

D. a zeitgeber

Question 8

The suprachiasmatic nucleus (SCN), the body's master circadian clock, is located in the:

A. pineal gland

B. retina

C. hypothalamus

D. hippocampus

Question 9

Which of the following correctly describes the hormone melatonin?

A. It is released by the pineal gland and its release is stimulated by darkness.

B. It is released by the SCN and its release is suppressed by darkness.

C. It is released by the pineal gland and its release is stimulated by bright light.

D. It is released by the hypothalamus and its release is suppressed by light.

Question 10

A newborn sleeps about 16 hours per day, with about 50% of that sleep spent in REM. Approximately how many hours of REM sleep does the newborn obtain each day?

A. 4 hours

B. 6 hours

C. 8 hours

D. 12 hours

Question 11

A 15-year-old does not feel sleepy until well after midnight, even though she gets into bed early. The most likely biological explanation is that, during adolescence:

A. the total amount of sleep needed increases sharply

B. melatonin is released earlier in the evening, advancing sleep onset

C. the proportion of sleep spent in REM rises to about 50%

D. melatonin is released later in the evening, delaying sleep onset

Question 12

Dmitri spends about eight hours in bed each night, but an overnight recording shows that he wakes briefly more than twenty times an hour and obtains almost no deep NREM Stage 3 sleep. He wakes unrefreshed every morning. Dmitri's sleep loss is best described as:

A. partial sleep deprivation, because his sleep is inadequate in quality

B. full sleep deprivation, because he obtains almost no restorative sleep

C. not sleep deprivation, because he spends eight hours in bed

D. an advanced sleep phase, because his sleep is broken up

Question 13

After a night without sleep, a driver takes much longer than usual to work out whether it is safe to turn across oncoming traffic. This impairment is best classified as a change in which domain of functioning?

A. affective

B. behavioural

C. cognitive

D. circadian

Question 14

The comparison drawn between one night of full sleep deprivation and blood alcohol concentration readings of 0.05 and 0.10 applies to changes in:

A. behavioural functioning only

B. affective and behavioural functioning

C. behavioural and cognitive functioning

D. affective and cognitive functioning

Question 15

A person with Delayed Sleep Phase Syndrome (DSPS) has a sleep-wake cycle that is:

A. shifted earlier than the conventional schedule

B. shifted later than the conventional schedule

C. normal in timing but reduced in total hours

D. reversed, so that REM and NREM swap over

Question 16

Petra drinks a strong coffee at about 9 pm each night, and eats her evening meal at a different time every day. Which statement best explains the effect of these two habits on her sleep?

A. Caffeine deepens NREM Stage 3 sleep, and meal times have no influence on the body clock.

B. Caffeine is a stimulant that delays sleep onset, but meal timing is an internal cue rather than a zeitgeber.

C. Caffeine is a stimulant that delays sleep onset, and irregular meal times weaken a zeitgeber that helps to entrain the body clock.

D. Caffeine acts on the pineal gland to raise melatonin, and irregular meal times advance the body clock.

Question 17

Shift work is one of the causes of a circadian rhythm sleep disorder named in the study design. Shift work produces such a disorder because it:

A. reduces the total number of hours of sleep a person needs

B. removes the person's need for zeitgebers altogether

C. reverses the order in which REM and NREM sleep occur

D. requires the person to sleep and wake at times that are out of step with their internal body clock and its light cues

Question 18

A zeitgeber is best defined as:

A. an external cue that helps to set (entrain) the circadian rhythm

B. an internal hormone that promotes sleep

C. the brain's master circadian clock

D. a brief, involuntary episode of sleep

Question 19

Keeping a bedroom cool helps a person fall asleep because the onset of sleep is associated with:

A. a rise in core body temperature

B. a drop in core body temperature

C. an increase in brain-wave frequency

D. an increase in melatonin suppression

Question 20

Using a bright phone screen in bed late at night tends to delay sleep because the blue light:

A. stimulates the pineal gland to release more melatonin

B. suppresses melatonin, signalling to the body that it is still daytime

C. lowers core body temperature below its usual level

D. advances the circadian clock to an earlier time

End of Topic 4 Test A

Test A — solutions

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	6	D	11	D	16	C
2	D	7	B	12	A	17	D
3	A	8	C	13	C	18	A
4	B	9	A	14	D	19	B
5	A	10	C	15	B	20	B

Q1. C — sleep cannot be observed directly, only inferred from consistent physiological and behavioural indicators, which is exactly what makes it a construct; A misdescribes what sleep is, while B and D confuse the construct itself with the measures used to infer it.

Q2. D — an active, awake-like brain, rapid eye movements and limp, paralysed limbs (atonia) together identify REM sleep, not an NREM stage or waking.

Q3. A — Stage 3 is the deepest, slow-wave, most restorative sleep; the easiest stage to wake from is Stage 1 (B), while an awake-like brain (C) and atonia (D) are features of REM.

Q4. B — the EOG (electro-oculograph) records eye movement and so detects the rapid eye movements of REM; the EMG records muscle activity, the EEG records the brain, and video monitoring shows only what is visible from outside the body.

Q5. A — as sleep deepens, brain-wave frequency decreases and amplitude increases (beta → alpha → theta → delta).

Q6. D — a sleep diary is a self-report of the person's own experience, so it is subjective; it records nothing about brain activity or sleep stage.

Q7. B — a ~90-minute cycle that repeats several times within one night has a period of less than 24 hours, so it is ultradian; a circadian rhythm has a period of about 24 hours.

Q8. C — the SCN sits in the hypothalamus; it is not the pineal gland, the retina or the hippocampus.

Q9. A — melatonin is made and released by the pineal gland, and its release is stimulated by darkness (and suppressed by light); the SCN only controls the timing of that release.

Q10. C — REM hours $= 16 \times 0.50 = 8$ hours.

Q11. D — during adolescence melatonin is released later in the evening, so sleep onset is delayed (the sleep-phase delay); this is biological, not a change in the amount of sleep needed.

Q12. A — partial sleep deprivation means sleep that is inadequate in **quantity or quality**; Dmitri's time in bed is normal but his sleep is fragmented and almost devoid of Stage 3, so its quality is inadequate. Full sleep deprivation (B) means no sleep at all, time in bed is not the same as sleep obtained (C), and nothing here indicates a shift in the *timing* of his cycle (D).

Q13. C — working out whether it is safe to turn is decision-making, a mental process, so it is a cognitive effect; "circadian" is not a domain of functioning.

Q14. D — the blood-alcohol comparison is drawn for the **affective and cognitive** effects of one night of full sleep deprivation only; extending it to behavioural functioning is the common error.

Q15. B — in DSPS the sleep-wake cycle is shifted later than the conventional schedule; a cycle shifted earlier is Advanced Sleep Phase Disorder.

Q16. C — caffeine is a stimulant, so a 9 pm coffee delays sleep onset; and the *timing* of meals is an external time cue (a zeitgeber), so eating at a different time each day gives the body clock an inconsistent cue and weakens its entrainment. A and D state incorrect physiology, and B wrongly reclassifies meal timing as an internal cue.

Q17. D — a circadian rhythm sleep disorder is a disorder of **timing**: shift work forces sleep and waking at hours that conflict with the internal body clock and with the light cues that entrain it. The amount of sleep needed is unchanged (A), zeitgebers still act on the worker (B), and the internal order of REM and NREM is unaffected (C).

Q18. A — a zeitgeber is an external cue (such as light) that entrains the circadian rhythm; the SCN and melatonin are the internal mechanism the cue acts on.

Q19. B — sleep onset is associated with a drop in core body temperature, which a cool room helps to bring about.

Q20. B — evening blue light suppresses melatonin, signalling to the body that it is still daytime, so sleep onset is delayed.

Topic 4 Test B — Short answer

Writing time: 50 minutes. Total 40 marks. No calculator, no notes. Answer all questions. Where more than one mark is available, full marks require the depth the command term and mark allocation ask for.

Question 1 (4 marks)

a. Explain why sleep is described as a psychological construct. 2 marks

b. Explain what it means to say that sleep is a *naturally occurring* altered state of consciousness, and name the two categories into which sleep is further divided. 2 marks

Question 2 (6 marks)

A researcher wants to build as complete a picture as possible of one participant's night of sleep, and so uses three of the measurement methods named in the study design: a sleep diary, video monitoring of the bedroom, and an overnight recording of the participant's brain activity.

a. Name the device the researcher would use for the overnight recording of brain activity, and state one thing that recording can show which the sleep diary cannot. 2 marks

b. Describe how brain-wave frequency and amplitude change as the participant moves from being awake and alert into deep NREM Stage 3 sleep. 2 marks

c. State what the video monitoring records, and explain one advantage it has over the sleep diary as a record of what the participant does during the night. 2 marks

Question 3 (4 marks)

In the evening, falling light levels set off a chain of events that ends in a person feeling sleepy. Trace that chain from the fading light through to the onset of sleepiness. Name, in order, each structure and substance involved — including the brain region that houses the body's master clock — and state what each one does.

Question 4 (6 marks)

A longitudinal study followed one person from infancy to middle adulthood, recording their total sleep per 24 hours and the time they spent in REM sleep per 24 hours at four points across the life span.

Age at recording	Total sleep per 24 h	Time in REM per 24 h
6 weeks	16 h	8 h
6 years	10 h	2 h 30 min
16 years	9 h	2 h
45 years	8 h	1 h 45 min

a. Using the data, state the percentage of total sleep spent in REM at 6 weeks and at 6 years. 2 marks

b. Describe the trend in this person's total sleep between 6 weeks and 45 years, and the trend in the share of that sleep taken up by REM. 2 marks

c. Give one explanation for the very high proportion of REM sleep in early infancy, and state one way in which the sleep of a healthy 75-year-old would typically differ from this person's sleep at 45. 2 marks

Question 5 (5 marks)

Over one week, 30 adult volunteers were randomly allocated to spend either eight hours or five hours in bed each night. On the eighth morning every volunteer completed a mood questionnaire (a higher score means more negative mood) and a 10-minute driving-simulator task on which the number of lane departures was counted. The group means are shown below.

Condition	n	Mean negative-mood score (out of 40)	Mean lane departures per 10 min
Eight hours in bed per night	15	11.6	1.8
Five hours in bed per night	15	24.3	6.4

a. Identify the independent variable in this investigation. 1 mark

b. State which domain of functioning each of the two dependent variables measures. 2 marks

c. Name the type of sleep deprivation experienced by the five-hour group, and state the blood alcohol concentration to which about 24 hours of *full* sleep deprivation would instead be comparable. 2 marks

Question 6 (7 marks)

A sleep clinic assesses three patients in one week.

- Ines, aged 17, cannot fall asleep before about 2:30 am and cannot be woken in time for school. During the school holidays she sleeps a full night on her own schedule and wakes refreshed.
- Bruno, aged 68, is asleep by about 6:30 pm and awake for the day by about 3 am. He obtains about eight hours of sleep and is not tired during the day, but he misses every evening activity.
- Delia, aged 40, works permanent night shifts. On her days off she sleeps well, but during her shift weeks she sleeps only fitfully during the day and is exhausted at work.

a. Name the circadian rhythm sleep disorder affecting Ines and the one affecting Bruno, and identify the cause of Delia's circadian rhythm sleep disorder. 3 marks

b. Bright light therapy is recommended for both Ines and Bruno. For each of them, state the time of day at which the light should be given and the direction in which their body clock will shift. 2 marks

c. Explain, with reference to melatonin, why bright light given at the time you stated for Ines moves her body clock in the required direction. 2 marks

Question 7 (8 marks)

Marisol is 19 and works evening shifts at a café. She eats her main meal whenever she gets home — sometimes at 6 pm, sometimes at 11 pm — and drinks two strong coffees after 8 pm to get through each shift. She watches videos on a bright phone screen in bed, and because she dislikes feeling cold she runs a heater in her bedroom all night. She goes to bed anywhere between 11 pm and 2 am and wakes at 7 am for university classes. Over the past month she has become irritable, has lost motivation, and cannot concentrate in lectures.

Explain how Marisol's habits are disrupting her sleep-wake cycle, and recommend how she could improve it. In your response you should: define a zeitgeber and explain the role zeitgebers play in regulating the sleep-wake cycle; analyse how each of daylight and blue light, temperature, and eating and drinking patterns is affecting Marisol's sleep, giving the mechanism in each case; recommend one specific sleep-hygiene change for each of those three; and explain how better sleep would be expected to help the difficulties she is now experiencing.

End of Topic 4 Test B

Test B — solutions

Q1. (a) Sleep is a **psychological construct** because it **cannot be directly observed or measured** — we cannot "see" sleep itself. Instead, we **infer** that a person is asleep from consistent **physiological indicators** (such as slowed heart rate and breathing, lowered body temperature and changed brain-wave activity) and **behavioural indicators** (such as closed eyes, lying still and reduced responsiveness). Because the state must be inferred from these measurable signs rather than observed directly, it is treated as a construct. **(b)** To say sleep is a **naturally occurring** altered state of consciousness means, first, that it **arises on its own** as part of the body's normal sleep-wake cycle, rather than having to be deliberately brought about; and second, that it is **altered** — a sleeper's level of awareness and quality of experience differ markedly from **normal waking consciousness** (reduced awareness of and responsiveness to the surroundings, distorted perception, dream-based thinking, a lost sense of time and no voluntary self-control). Sleep is further categorised into **REM sleep** and **NREM sleep**.

Q2. (a) The device is the **EEG (electroencephalograph)**, which records the **electrical activity of the brain**. Because it shows brain activity directly, it can reveal which **sleep stage** the participant is in (from the brain-wave pattern) — something a subjective sleep diary cannot do. **(b)** As the participant moves from being awake and alert into deep NREM Stage 3 sleep, the brain-wave **frequency decreases** (the waves become slower and more spread out) and the **amplitude increases** (the waves become taller) — the progression beta → alpha → theta → delta. **(c) Video monitoring** records the participant's **observable behaviour during the night** — movements and restlessness, getting out of bed, sleep-talking or sleep-walking, and the times at which these occur. Its advantage over the sleep diary is that it is an **objective** record made **as the events happen**, whereas the diary depends on the participant's own memory and judgement the next morning — and a sleeper is by definition unaware of most of what they do during the night, so they cannot report it.

Q3. As the evening light fades, the change is detected by the **retina** of the eyes. This low-light signal is sent to the **suprachiasmatic nucleus (SCN)**, the master clock located in the **hypothalamus**. The SCN then signals the **pineal gland**, which responds by **increasing** its release of the hormone **melatonin**. Rising melatonin **promotes sleep**, so the person begins to feel drowsy. In order: **darkness → retina (eyes) → SCN (hypothalamus) → pineal gland → melatonin → sleep.** (Full marks: the retina, the SCN in the hypothalamus, the pineal gland and melatonin all correctly named and in order.)

Q4. (a) At **6 weeks**, REM is 8 h out of 16 h $= 8 \div 16 =$ **50%**. At **6 years**, REM is 2 h 30 min out of 10 h $= 2.5 \div 10 =$ **25%**. **(b) (i)** The **total amount of sleep falls** steadily across the life span — from about **16 hours** per 24 hours in early infancy to about **8 hours** in middle adulthood, with the steepest fall in the early years. **(ii)** The **proportion of sleep spent in REM also falls** — from about **50%** at 6 weeks to about **25%** by age 6, after which it settles at roughly **20–25%** through adolescence and adulthood. Because *both* the total and the proportion decrease, the hours of REM drop far more steeply than the total hours (8 h down to about 1 h 45 min). **(c)** The very high proportion of REM in early infancy is thought to support the **rapid brain development** of the first months of life: REM provides a high level of internal brain stimulation at a time when an enormous number of neural connections are being formed and refined, so less REM is needed once the brain has matured. Compared with this person at 45, a healthy **75-year-old** would typically obtain **slightly less total sleep** (about 7–8 hours) and, in particular, **much less deep NREM Stage 3 sleep** with **more frequent night-time awakenings**, so their sleep is **lighter and more fragmented**.

Q5. (a) The **independent variable** is the **number of hours spent in bed each night** — eight hours or five hours. **(b)** The **mean negative-mood score** measures **affective** functioning (emotion and mood). The **mean number of lane departures** measures **behavioural** functioning (observable performance and coordination on the task). **(c)** The five-hour group experienced **partial sleep deprivation** — they slept every night, but less than the roughly 7–9 hours an adult needs. About **24 hours** of **full** sleep deprivation is instead comparable to a blood alcohol concentration of about **0.10**. (About 17 hours awake is comparable to 0.05, and the comparison is drawn for affective and cognitive functioning.)

Q6. (a) Ines has **Delayed Sleep Phase Syndrome (DSPS)** — her sleep-wake cycle is shifted **later** than the conventional schedule, which is why she sleeps normally in the holidays when free to follow it. **Bruno** has **Advanced Sleep Phase Disorder (ASPD)** — his cycle is shifted **earlier**. **Delia's** circadian rhythm sleep disorder is caused by **shift work**: her roster requires her to sleep and wake at times that conflict with her internal body clock. **(b) Ines:** bright light in the **morning**, to shift her body clock **earlier** (a phase **advance**). **Bruno:** bright light in the **evening**, to shift his body clock **later** (a phase **delay**). **(c)** Ines's clock is set too late, so it must be advanced. Morning bright light is detected by the retina and signals the **SCN**, which **shuts off the pineal gland's release of melatonin earlier** than it otherwise would, marking that point as the start of her biological day. Because the fall in melatonin — and with it the whole cycle — now occurs earlier, on the following days the **evening rise in melatonin also comes earlier**, so she begins to feel sleepy earlier and can wake earlier. The clock has therefore moved **earlier**, which is the direction DSPS requires. (Evening light would hold the melatonin rise back and delay her clock further, worsening the disorder.)

Q7. *Model response (8 marks).* A **zeitgeber** is an **external cue that helps to entrain (set) the circadian rhythm**. Left to itself the human body clock runs a little longer than 24 hours, so the **suprachiasmatic nucleus (SCN)** — the master clock in the hypothalamus that controls the pineal gland's release of **melatonin** — must be reset each day by these external cues. Marisol is mismanaging all three of the cues named in the study design, so her sleep-wake cycle is being pushed later and is never allowed to settle into a stable pattern.

Daylight and blue light. Light is the most powerful zeitgeber. The **blue light** of Marisol's phone screen reaches her retina late at night and **suppresses melatonin**, signalling to her SCN that it is still daytime, so **sleep onset is delayed**. **Recommendation:** stop screen use about an hour before bed and dim the lights, and get **bright daylight soon after waking**, which anchors the start of her biological day and helps pull her cycle earlier.

Temperature. Sleep onset is associated with a **drop in core body temperature**. Running a heater all night keeps Marisol's bedroom warm and makes it **harder for her body to lose heat**, so the fall in core temperature that helps sleep begin is blunted and her sleep is more easily disrupted through the night. **Recommendation:** turn the heater off and keep the bedroom **cool**, using bedding for warmth instead.

Eating and drinking patterns. When Marisol eats and drinks is also a time cue. Because her main meal falls anywhere between 6 pm and 11 pm, her body receives an **inconsistent daily cue**, which weakens the entrainment of her sleep-wake cycle; and two strong coffees after 8 pm supply **caffeine**, a **stimulant** that raises alertness and **delays sleep onset** for hours afterwards. **Recommendation:** eat her main meal at **roughly the same time each day**, and move her caffeine to earlier in the shift (or switch to a caffeine-free drink after mid-afternoon), avoiding a heavy meal immediately before bed.

Together with a **consistent bedtime and wake time** — rather than anywhere between 11 pm and 2 am — these changes would let her zeitgebers entrain the SCN so that melatonin rises at a time compatible with a 7 am start. She would then obtain the roughly 7–9 hours she needs instead of being **partially sleep deprived**, and the difficulties she describes would be expected to ease: better mood and emotional control (**affective**), restored motivation and engagement (**behavioural**), and improved concentration in lectures (**cognitive**) — which in turn supports her broader mental wellbeing.

(Full marks require: a correct definition of a zeitgeber and its role in entraining the sleep-wake cycle; all three study-design zeitgebers analysed for Marisol with the mechanism given in each case; a specific sleep-hygiene recommendation for each of the three; and a link from improved sleep back to the affective, behavioural and cognitive difficulties described.)