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Year 12 *Trial Exam Paper*

2015

PHYSICS

Written examination

Worked solutions
Section A – Core studies
Section B – Detailed studies

This book contains:

- worked solutions
- mark allocations
- explanatory notes
- tips

SECTION A – Core studies

Area of study – Motion in one and two dimensions

Question 1a.

Worked solution

The velocity must first be calculated by using the period of rotation; 4 cycles per second means a period of 0.25 s.

$$v = \frac{2\pi r}{T}$$
$$= \frac{2 \times \pi \times 0.3}{0.25}$$
$$= 7.54 \text{ m s}^{-1}$$
$$\Sigma F = \frac{mv^2}{r}$$
$$= \frac{0.2 \times 7.54^2}{0.3}$$
$$= 37.9 \text{ N}$$

38 N

Mark allocation: 3 marks

- 1 mark for correctly calculating the velocity
- 1 mark for correct values in the net force equation (or 2 marks if a single equation was used as described in the tip below)
- 1 mark for the correct answer

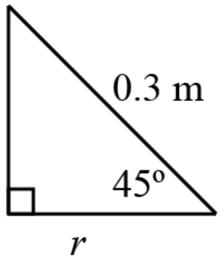
Tip

- *A possible short-cut would be to combine the two equations used above, so that:* $\Sigma F = \frac{4\pi^2 rm}{T^2}$

Question 1b.

Worked solution

Calculate the radius of the circle that the ball moves through.

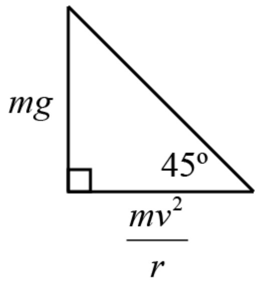


$$\cos 45° = \frac{r}{0.3}$$

$$r = 0.3\cos 45°$$

$$= 0.212 \text{ m}$$

Combine the weight force and net force vectors.



Note that for a right-angled triangle with a 45° corner, the opposite and adjacent sides are equal.

$$mg = \frac{mv^2}{r}$$

$$v = \sqrt{rg}$$

$$= \sqrt{0.212 \times 10}$$

$$= 1.46 \text{ m s}^{-1}$$

1.5 m s^{-1}

Mark allocation: 3 marks

- 1 mark for correctly calculating the radius
- 1 mark for correct values in the force vectors equation
- 1 mark for the correct answer

Tip

- *Remember that distances (string length, radius) and force vectors (weight, tension, centripetal force) should never be drawn on the same triangles. The only thing they have in common is that they use the same angle (45° in this case).*

Question 2a.

Worked solution

$$m_1u_1 = m_2v_2$$
$$0.07 \times 1.9 = 0.1 \times v_2$$
$$v_2 = 1.33 \text{ m s}^{-1}$$

1.3 m s^{-1}

Mark allocation: 2 marks

- 1 mark for correct values in the correct equation
- 1 mark for the correct answer

Question 2b.

Worked solution

Taking the easterly direction as positive:

Impulse $= m\Delta v$

$$= 0.07(0 - 1.9)$$
$$= -0.133 \text{ N s}$$

Magnitude: 0.13 N s	Direction: West

Mark allocation: 3 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct magnitude
- 1 mark for the correct direction

Tip

- *Be sure to indicate which direction (east or west, up or down) is positive and which direction is negative, and use the signs on your vectors accordingly.*

Question 3a.

Worked solution

The time taken for an object to reach the peak of its flight is half the total flight time (if it returns to the original elevation).
Consider just the vertical component of motion:

$t = 2.6\ \text{s}$

$a = -10\ \text{m s}^{-2}$

$v = 0\ \text{m s}^{-1}$

$$\begin{aligned} x &= vt - \frac{1}{2}at^2 \\ &= 0 - \frac{1}{2} \times -10 \times 2.6^2 \\ &= 33.8\ \text{m} \end{aligned}$$

34 m

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Tip

- *The vertical component of motion is often an easy way to approach a projectile motion problem. Acceleration and final velocity are both known and the time to the peak is exactly half the total time (for symmetrical flight).*

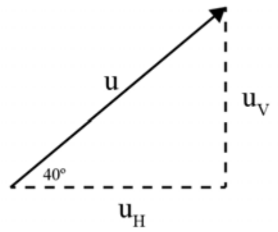
Question 3b.

Worked solution

Find the vertical component of the initial velocity:

$$v = 0$$
$$t = 2.6$$
$$a = -10$$
$$u_v = v - at$$
$$= 0 - -10 \times 2.6$$
$$= 26 \text{ m s}^{-1}$$

Find the horizontal component of initial velocity:



$$\tan 40° = \frac{u_v}{u_h}$$
$$u_h = \frac{u_v}{\tan 40°}$$
$$= \frac{26}{\tan 40°}$$
$$= 31.0 \text{ m s}^{-1}$$

Find the distance travelled in the horizontal component of motion:

$$u_h = 31$$
$$t = 5.2$$
$$x = u_h t$$
$$= 31 \times 5.2$$
$$= 161 \text{ m}$$

161 m

Mark allocation: 3 marks

- 1 mark for correctly calculating the vertical component of velocity
- 1 mark for correctly calculating the horizontal component of velocity
- 1 mark for the correct answer

Question 4a.

Worked solution

$$F = -k\Delta x$$
$$= 2000 \times (0.04 - 0.09)$$
$$= 100 \text{ N}$$

100 N

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Tip

- *Remember that with Hooke's law, Δx refers to the change in length of the spring and must be in metres.*

Question 4b.

Worked solution

The energy stored in the spring will be converted into gravitational potential energy.

$$U_s = U_g$$

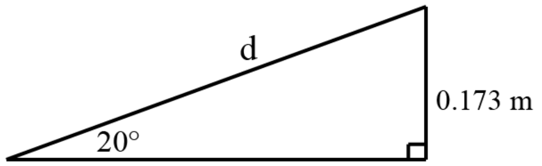
$$\frac{1}{2}k\Delta x^2 = mg\Delta h$$

$$\frac{1}{2} \times 2000 \times 0.03^2 = 0.52 \times 10 \times \Delta h$$

$$0.9 = 5.2\Delta h$$

$$\Delta h = 0.173 \text{ m}$$

The height given by the gravitational potential energy equation is the vertical height gained by the trolley. To find the distance *d*, use trigonometry.



$$\sin 20° = \frac{0.173}{d}$$

$$d = \frac{0.173}{\sin 20°}$$

$$= 0.506 \text{ m}$$

0.51 m

Mark allocation: 3 marks

- 1 mark for the correct values in the correct energy equation
- 1 mark for the correct value of Δh
- 1 mark for the correct answer

Tip

- *When using the formula for gravitational potential energy (mgΔh), it may be helpful to compare it to the formula for work done (Fx), where F = mg and x = Δh. Just like the formula for work done, the force and displacement vectors must be parallel. Hence, the height given by the formula for gravitational potential energy gives the height as a vector parallel to the weight force.*

Question 4c.

Worked solution

Method 1 – energy conservation

$U_g = E_k$

$mg\Delta h = \frac{1}{2}mv^2$ note that the *m* cancels out

$10 \times 1.1 = \frac{1}{2} \times v^2$

$v = \sqrt{22}$

$= 4.69 \text{ m s}^{-1}$

Method 2 – constant acceleration formula

$v^2 = u^2 + 2ax$

$0 = u^2 + 2 \times -10 \times 1.1$

$u = \sqrt{22}$

$= 4.69 \text{ m s}^{-1}$

4.7 m s^{-1}

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Question 4d.

Worked solution

By doubling the compression of the spring, four times as much energy will be stored in it because the spring's potential energy is proportional to the displacement squared:

$$U_s = \frac{1}{2}kx^2$$

With four times as much energy from the spring, the launch velocity will be doubled because velocity is proportional to the square root of kinetic energy:

$$E_k = \frac{1}{2}mv^2 \text{ or } v = \sqrt{\frac{2E_k}{m}}$$

With four times as much energy from the spring, the ball will travel four times higher because gravitational potential energy is directly proportional to displacement:

$$U_g = mg\Delta h \text{ or } \Delta h = \frac{U_g}{mg}$$

Mark allocation: 3 marks

- 1 mark for identifying a factor of four increase in the spring's potential energy
- 1 mark for identifying a factor of two increase in launch velocity
- 1 mark for identifying a factor of four increase in height

Note: that the equations are necessary but not sufficient for each mark. Each one must be accompanied by an appropriate explanation.

Question 5a.

Worked solution

To find the tension, consider just the raft.
To maintain a constant speed, $\Sigma F = 0$, which means the tension force must equal the drag force.

2500 N

Mark allocation: 1 mark

- 1 mark for correctly calculating the tension

Question 5b.

Worked solution

First find the acceleration of the system:

$$\Sigma F = ma$$
$$2500 - 1500 = (800 + 250) \times a$$
$$a = \frac{1000}{1050}$$
$$= 0.95 \text{ m s}^{-2}$$

Now apply Newton's second law to just the raft:

$$\Sigma F = ma$$
$$F_{\text{T}} - 1500 = 250 \times 0.95$$
$$F_{\text{T}} = 1738 \text{ N}$$

1740 N

Mark allocation: 4 marks

- 1 mark for the correct values in the first application of Newton's second law
- 1 mark for the correct value of acceleration
- 1 mark for the correct values in the second application of Newton's second law
- 1 mark for the correct answer

Question 6a.

Worked solution

On the outside-top of a vertical circle:

$$\Sigma F = \frac{mv^2}{r} = mg - N$$

For the passengers to lose contact with their seats, $N = 0$ and so:

$$\frac{mv^2}{r} = mg \text{ or } v = \sqrt{rg}$$

In this case:

$$v = \sqrt{4 \times 10}$$
$$= 6.32 \text{ m s}^{-1}$$

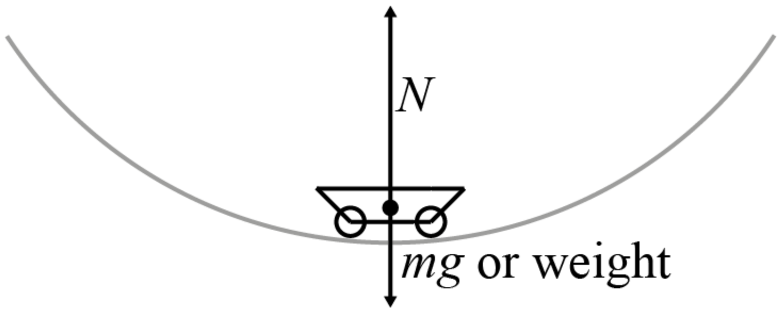
6.3 m s^{-1}

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Question 6b.

Worked solution



Mark allocation: 2 marks

- 1 mark for arrows of the correct magnitude. The arrow pointing towards the centre must be twice as large as the arrow pointing down.
- 1 mark for correct labels.

Note that gravity is not an acceptable label; it is a field, not a force.

Question 6c.

Worked solution

Apparent weight comes from the normal reaction force *N*.
At the bottom of a vertical circle:

$$\Sigma F = \frac{mv^2}{r} = N - mg$$

In this case:

$$\frac{70 \times v^2}{6} = 1400 - 70 \times 10$$

$$v = \sqrt{\frac{6 \times 700}{70}}$$

$$= 7.7 \text{ m s}^{-1}$$

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct working out

Question 7a.

Worked solution

$$g = \frac{GM}{R^2}$$

$$= \frac{6.67 \times 10^{-11} \times 1.02 \times 10^{26}}{\left(2.46 \times 10^7\right)^2}$$

$$= 11.2 \text{ N kg}^{-1}$$

11.2 N kg^{-1}

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Question 7b.

Worked solution

Because Earth and Neptune orbit the same body (the Sun), we can use the fact that $\frac{T^2}{R^3} =$ a constant for all satellites of the same body:

$$\frac{T_{\text{Neptune}}^2}{R_{\text{Neptune}}^3} = \frac{T_{\text{Earth}}^2}{R_{\text{Earth}}^3}$$

$$\frac{T_{\text{Neptune}}^2}{\left(4.50\times10^{12}\right)^3} = \frac{365.25^2}{\left(1.50\times10^{11}\right)^3}$$

$$T_{\text{Neptune}} = \sqrt{\frac{365.25^2 \times \left(4.50\times10^{12}\right)^3}{\left(1.50\times10^{11}\right)^3}}$$

$$= 60016.69 \text{ days}$$

60 000 days

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Tip

- $\frac{T^2}{R^3} = \frac{4\pi^2}{GM} = \text{constant}$ *is sometimes called Kepler's Law and is very useful in solving problems where there are multiple satellites of the same body, i.e. planets around the sun and moons around a planet.*

Area of study – Electronics and photonics

Question 8a.

Worked solution

First calculate the effective resistance of the parallel section:

$$\frac{1}{R_{\text{eff}}} = \frac{1}{500} + \frac{1}{1500}$$

$$= \frac{3}{1500} + \frac{1}{1500}$$

$$R_{\text{eff}} = \frac{1500}{4}$$

$$= 375\ \Omega$$

Sum the components in series:

$$R_{\text{eff}} = 1000 + 375$$

$$= 1375\ \Omega$$

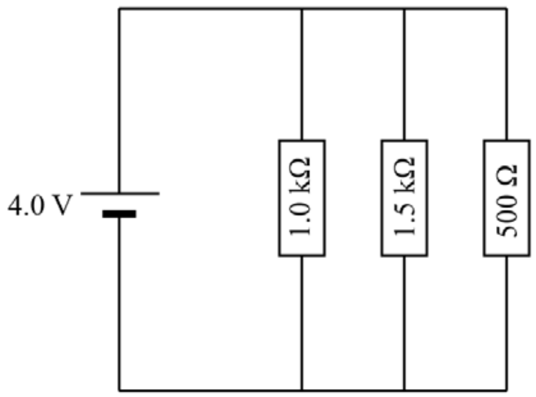
1375 Ω

Mark allocation: 2 marks

- 1 mark for correctly calculating the effective resistance of the parallel resistors
- 1 mark for the correct answer

Question 8b.

Worked solution



Mark allocation: 2 marks

- 1 mark for the correct arrangement
- 1 mark for using the correct symbols

Question 8c.

Worked solution

The minimum amount of power will be consumed when the three resistors are arranged in series.

$$R_{eff} = 500 + 1000 + 1500$$
$$= 3000\ \Omega$$

$$P = \frac{V^2}{R}$$
$$= \frac{4^2}{3000}$$
$$= 0.0053\ \text{W}$$

0.0053 W

Mark allocation: 2 marks

- 1 mark for calculating the effective resistance
- 1 mark for the correct answer

Question 9a.

Worked solution

LEDs are non-ohmic, so analyse current through the resistors.

$$I = \frac{V}{R}$$
$$= \frac{6-1.2}{500}$$
$$= 0.0096 \text{ A}$$

This flows through both parallel paths and combines to flow through the battery:
$2 \times 0.0096 = 0.0192$ A

19 mA

Mark allocation: 2 marks

- 1 mark for the correct values in the correct equation
- 1 mark for the correct answer

Question 9b.

Worked solution

A higher resistance will reduce the current to LED 1 reducing its brightness. It will have no impact on the other LED in parallel with it.

A

Mark allocation: 2 marks

- 2 marks for the correct answer

Tip

- *Remember that parallel paths in a circuit have the same voltage drop but their current flows are completely independent.*

Question 10a.

Worked solution

Reading from the graph

28 kΩ

Mark allocation: 1 mark

- 1 mark for the correct answer (accept 27–29 kΩ)

Question 10b.

Worked solution

At 16°C, the resistance of the thermistor is 15 kΩ. Applying the voltage divider formula:

$$\frac{V_{\text{in}}}{V_{\text{out}}} = \frac{R_1 + R_2}{R_2}$$

$$\frac{4.5}{V_{\text{out}}} = \frac{25}{10}$$

$$V_{\text{out}} = 1.8 \text{ V}$$

1.8 V

Mark allocation: 2 marks

- 1 mark for the correct values in the voltage divider formula
- 1 mark for the correct answer

Question 10c.

Worked solution

A

As the temperature increases, the resistance of the thermistor will increase.
A greater share of the voltage will now drop across the thermistor, activating the alarm.

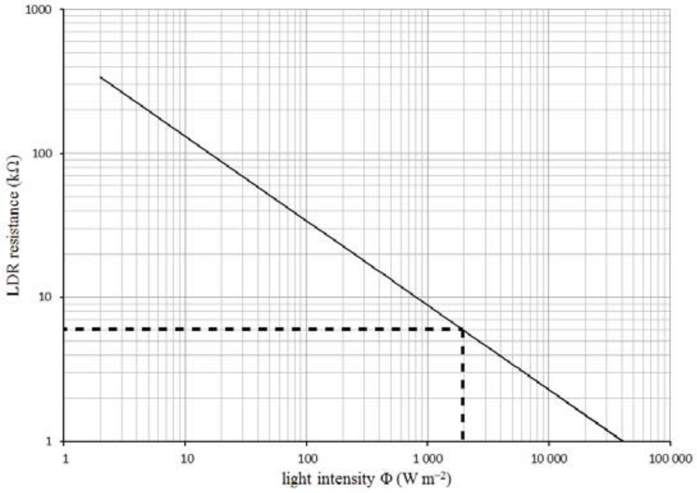
Mark allocation: 3 marks

- 1 mark for correctly choosing A
- 1 mark for correctly relating temperature change to thermistor resistance
- 1 mark for identifying the increase in voltage across the thermistor

Question 11a.

Worked solution

From the graph, when resistance is 6 kΩ, light intensity is 2000 W m^{-2}.



2000 W m^{-2}

Mark allocation: 1 mark

- 1 mark for the correct answer

Question 11b.

Worked solution

Find V_{out} by transposing the voltage divider formula:

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{R_1 + R_2}$$

$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}, \text{ where } V_{in} = 9.0, R_2 = 40\,000, R_1 = R_{LDR}$$

When φ = 20 W m^{-2}, R_{LDR} = 90 kΩ.

$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$$

$$= 9 \times \frac{40\,000}{90\,000 + 40\,000}$$

$$= 2.78 \text{ V}$$

When φ = 2000 W m^{-2}, R_{LDR} = 6.0 kΩ (using the same form of the voltage divider formula as above).

$$V_{out} = 9 \times \frac{6000}{6000 + 40\,000}$$

$$= 7.83 \text{ V}$$

Maximum: 7.8 V

Minimum: 2.8 V

Mark allocation: 4 marks

- 1 mark for the correct values in each equation
- 1 mark for each correct answer

Tips

- *Have different forms of the voltage divider formula on your sheet of summary notes.*
- *If all values of resistance are in kΩ, you do not need to convert into Ω e.g.*

$$9 \times \frac{6000\,\Omega}{6000\,\Omega + 40\,000\,\Omega} = 9 \times \frac{6\text{ k}\Omega}{6\text{ k}\Omega + 40\text{ k}\Omega}$$

Question 11c.

Worked solution

LDRs have a relatively slow refresh rate or response time. They are unable to change their resistance from high to low (or vice versa) quickly enough to enable high bandwidth signals to be processed.
More commonly used devices are photodiodes or phototransistors.

Mark allocation: 2 marks

- 1 mark for mentioning LDRs' slow refresh rate or response time
- 1 mark for mentioning either photodiodes or phototransistors

Question 12a.

Worked solution

The gain of an amplifier is equal to the gradient of the linear section.

$$\text{gain} = \frac{\text{rise}}{\text{run}}$$
$$= \frac{12}{20\times10^{-3}}$$
$$= 600$$

Mark allocation: 1 mark

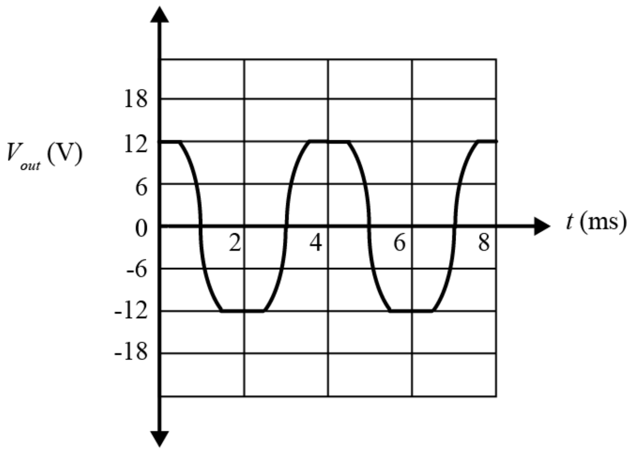
- 1 mark for the correct answer

Tip

- *These graphs often use mV as the input voltage. Remember to factor this into your calculations.*

Question 12b.

Worked solution



Mark allocation: 3 marks

- 1 mark for the correct phase (non-inverted)
- 1 mark for the correct scale (wave between ± 12 V)
- 1 mark for clipping at both high and low limits

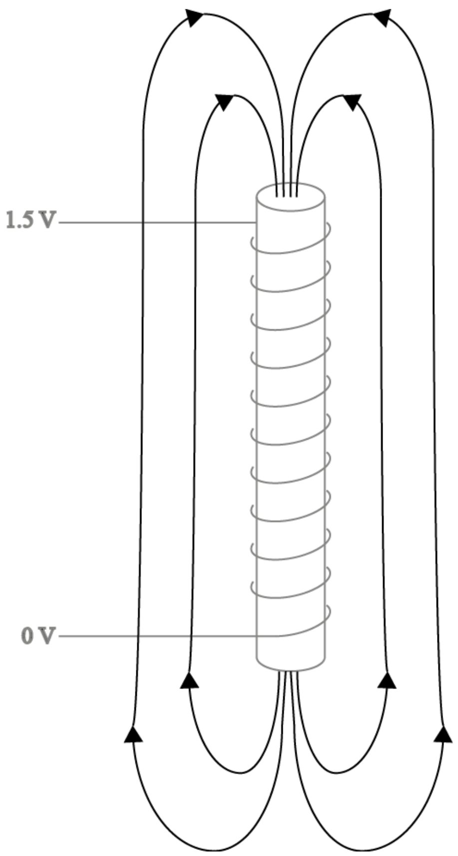
Tip

- *When sketching transformer graphs, focus on the high and low limits and mark these points on your graph first. If any clipping is going to occur, it will be here. Join the points together, remembering that the frequency of the wave never changes.*

Area of study – electric power

Question 13a.

Worked solution



Mark allocation: 2 marks

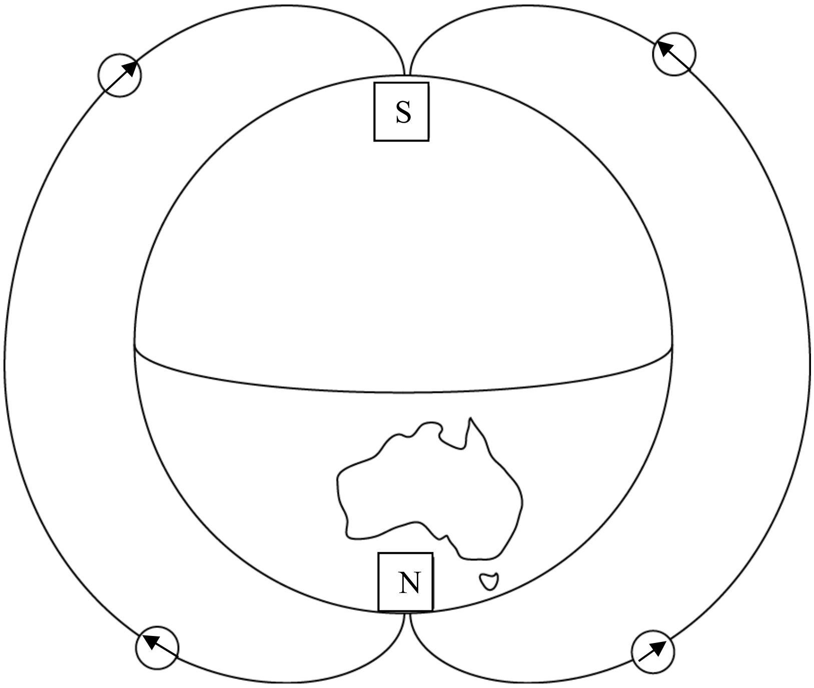
- 1 mark for arrows in the correct direction
- 1 mark for continuous lines that provide the shape of the field and do not cross or touch (*must* also be in the correct direction)

Tip

- *Imagine wrapping your right hand around the solenoid with your fingers pointing in the direction that the current flows through the windings. Your thumb now points in the direction of the magnetic field through the core.*

Question 13c.

Worked solution



Mark allocation: 2 marks

- 1 mark for all four arrows being correctly drawn
- 1 mark for both N and S being correctly placed

Tip

- *Remember that the north pole of a magnetic compass will point to the* ***geographic north*** *because it is a* ***magnetic south*** *pole.*

Question 14a.

Worked solution

$$F = nBIl$$
$$= 80 \times 0.005 \times 0.5 \times 0.12$$
$$= 0.024 \text{ N}$$

Use the right-hand slap rule to find direction.

Magnitude	0.024 N
Direction	A

Mark allocation: 3 marks

- 1 mark for the correct values in the correct formula
- 1 mark for the correct magnitude
- 1 mark for the correct direction

Question 14b.

Worked solution

The force on PQ is constant until the direction of current is reversed by the split-ring commutator. When the current is reversed, so too is the force.

A

Mark allocation: 2 marks

- 2 marks for the correct answer

Tip

- *Although the force doesn't change its magnitude, a motor like the one illustrated will suffer a reduction in torque as the coil rotates towards a vertical position. This is why motors in the real world often use multiple coils.*

Question 15a.

Worked solution

Peak–peak voltage must first be converted to RMS:

$$V_{\text{RMS}} = \frac{V_{\text{P-P}}}{2\sqrt{2}}$$

$$= \frac{94}{2\sqrt{2}}$$

$$= 33.2 \text{ V}$$

$$\frac{N_{\text{primary}}}{N_{\text{secondary}}} = \frac{V_{\text{primary}}}{V_{\text{secondary}}} = \frac{I_{\text{secondary}}}{I_{\text{primary}}}$$

$$= \frac{33.2}{5.5}$$

$$= 6.0$$

6.0

Mark allocation: 3 marks

- 1 mark for the correct conversion from peak–peak to RMS
- 1 mark for the correct values in the transformer equation
- 1 mark for the correct answer

Question 15b.

Worked solution

The voltmeter briefly registers a voltage but then returns to zero.

Mark allocation: 2 marks

- 1 mark for describing a voltage being read by the meter
- 1 mark for stating that the meter returned to zero

Question 16a.

Worked solution

$$\varepsilon = \frac{\Delta\phi}{\Delta t}$$
$$= \frac{\pi \times 0.2^2 \times \left(0.05 - (-0.05)\right)}{2}$$
$$= 0.0063\,\text{V}$$

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Tip

- *Remember that magnetic fields are a vector quantity and that opposite directions must take opposite signs (+ and –).*

Question 16b.

Worked solution

CLOCKWISE

Lenz's law states that a system will act to oppose a change in flux.
As the flux into the page is weakened, a clockwise current will be induced to replace the flux being lost.

Mark allocation: 3 marks

- 1 mark for choosing the correct direction
- 1 mark for correctly stating Lenz's law
- 1 mark for explaining how the current will oppose the change in flux

Question 17a.

Worked solution

An alternating current is required in the primary coil of the transformer.
The alternating current induces a changing magnetic field in the core of the transformer.
The changing magnetic field is directed through the secondary coil where it induces an alternating current.

Mark allocation: 3 marks

- 1 mark for mentioning an alternating current in the primary coil
- 1 mark for mentioning a changing flux
- 1 mark for mentioning an induced current in the secondary coil

Question 17b.

Worked solution

RMS voltage is directly equivalent to DC voltage,
i.e. 12 V DC = 12 V RMS

12 V

Mark allocation: 1 mark

- 1 mark for calculating the correct voltage

Question 17c.

Worked solution

At 3.0 kW:

$$P = IV$$

$$3000 = I \times 1200$$

$$I = \frac{3000}{1200}$$

$$= 2.5 \text{ A}$$

2.5 A

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Question 17d.

Worked solution

$1200 - 1168 = 32$ V dropped in wire

$$R = \frac{V}{I}$$
$$= \frac{32}{2.0}$$
$$= 16\ \Omega$$

$$\frac{16\ \Omega}{4.0\ \text{km}} = 4.0\ \Omega\ \text{km}^{-1}$$

$4.0\ \Omega\ \text{km}^{-1}$

Mark allocation: 3 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct total resistance
- 1 mark for the correct answer

Tip

- *The V in Ohm's law (V = IR) refers to voltage dropped in a component, not the voltage carried.*

Question 17e.

Worked solution

Reducing voltage will increase the current: $P = IV$
The power loss in the transmission wire will be nine times greater.
Power loss is proportional to the square of current: $P_{\text{loss}} = I^2 R$

Mark allocation: 3 marks

- 1 mark for relating a reduction in voltage to an increase in current
- 1 mark for relating power loss to the square of the current
- 1 mark for stating that power loss will increase by a factor of 9

Tip

- *Answering questions like these with dot-points is a good way to ensure you have answered it fully; a 3-mark question requires an answer in three parts.*

Question 18a.

Worked solution

Take care when converting quantities to SI units:

$25 \text{ mT} = 25 \times 10^{-3} \text{ T}$

$20 \text{ cm}^2 = 20 \times 10^{-4} \text{ m}^2$

Consider the time for a quarter turn because this is where the greatest change in flux occurs:

$$\Delta t = \frac{T}{4}$$

$$= \frac{0.10}{4} = 0.025 \text{ s}$$

Use Faraday's law and solve for n:

$$\varepsilon = n\frac{\Delta\phi}{\Delta t}$$

$$0.10 = n\frac{20 \times 10^{-4} \times 25 \times 10^{-3}}{0.025}$$

$$n = 50$$

50 loops

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Question 18b.

Worked solution

emf is directly proportional to frequency; therefore, a six-fold increase in emf requires a six-fold increase in frequency.

Initial frequency:
$$\begin{aligned} f &= \frac{1}{T} \\ &= \frac{1}{0.1} = 10\ \text{Hz} \end{aligned}$$

New frequency: $6 \times 10\ \text{Hz} = 60\ \text{Hz}$

Alternatively, use Faraday's law and solve for Δt and then convert from period to frequency:

$$\varepsilon = n\frac{\Delta\phi}{\Delta t}$$

$$0.60 = 50 \times \frac{20 \times 10^{-4} \times 25 \times 10^{-3}}{\Delta t}$$

$$\Delta t = 0.004\,167\ \text{s}$$

$$\begin{aligned} T &= 4 \times \Delta t \\ &= 4 \times 0.004\,167 = 0.0167\ \text{s} \end{aligned}$$

$$\begin{aligned} f &= \frac{1}{T} \\ &= \frac{1}{0.0167} = 60\ \text{Hz} \end{aligned}$$

60 Hz

Mark allocation: 2 marks

- 1 mark for the correct values in either equation
- 1 mark for the correct answer

Area of study – Interactions of light and matter

Question 19a.

Worked solution

$$E = \frac{hc}{\lambda}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{405 \times 10^{-9}}$$
$$= 4.9 \times 10^{-19} \text{ J}$$

4.9×10^{-19} J

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Tip

- *It is no longer permissible to replace the unit in the answer box. This question must be answered in joules, not electron-volts.*

Question 19b.

Worked solution

$$\lambda_{\text{X-ray}} = \frac{c}{f}$$
$$= \frac{3.0 \times 10^{8}}{8.9 \times 10^{16}}$$
$$= 3.37 \times 10^{-9} \text{ m, or } 3.37 \text{ nm}$$
$$\frac{\lambda_{\text{Blu-ray}}}{\lambda_{\text{X-ray}}} = \frac{405}{3.37}$$
$$= 120$$

Mark allocation: 2 marks

- 1 mark for calculating the correct X-ray wavelength
- 1 mark for correctly calculating the ratio

Tip

- *Be careful not to round off before giving your final answer. Small rounding errors can compound significantly.*

Question 19c.

Worked solution

$$\lambda = \frac{h}{mv}, v = \frac{h}{m\lambda}$$

$$v = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 405 \times 10^{-9}}$$

$$= 1797 \text{ m s}^{-1}$$

1800 m s^{-1}

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Tip

- *Remember that the only value of Plank's constant that can be used in this equation is* $h = 6.63 \times 10^{-34}$ J s.

Question 20a.

Worked solution

Path difference to the second bright band is 2λ:

$$PD = 2 \times 532 \times 10^{-9}$$
$$= 1.06 \times 10^{-6} \text{ m}$$

Mark allocation: 1 mark

- 1 mark for the correct answer

Question 20b.

Worked solution

A longer wavelength would result in an increased path difference.

Mark allocation: 1 mark

- 1 mark for circling the correct answer

Question 20c.

Worked solution

Reduce the distance between the slits.
Increase the distance from the slits to the screen.

Mark allocation: 2 marks

- 1 mark each for identifying the two methods

Question 20d.

Worked solution

Dark bands are formed when light from the two slits arrives out of phase and undergoes destructive interference.
This is evidence for the wave model of light.

Mark allocation: 2 marks

- 1 mark for naming and describing destructive interference
- 1 mark for linking this to light as a wave

Question 21a.

Worked solution

Highest frequency indicates the largest energy as $E = hf$.
This photon is a result of a transition to the ground state.

$$\begin{aligned}\Delta E &= 10.4 - 2.9 \\ &= 7.5 \text{ eV}\end{aligned}$$

$$\begin{aligned}f &= \frac{E}{h} \\ &= \frac{7.5}{4.14 \times 10^{-15}} \\ &= 1.81 \times 10^{15} \text{ Hz}\end{aligned}$$

1.8×10^{15} Hz

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Question 21b.

Solution and mark allocation: 2 marks

- 1 mark for explaining that emission spectra include transitions between excited states
- 1 mark for explaining that absorption spectra only include transitions from the ground state to excited states

Tip

- *Regarding absorption spectra: transitions between excited states occur much less frequently due to a much lower probability of a photon interacting with an excited electron. This is why only transitions from the ground state are shown on an absorption spectrum.*

Question 21c.

Solution and mark allocation: 2 marks

- 1 mark for mentioning that all particles, including electrons, have a wavelength related to their energy
- 1 mark for saying that only energies that give a wavelength that forms a standing wave in the orbit of the atom are allowed

Question 22a.

Worked solution

$$E_k(\max) = hf - W$$
$$W = hf - E_k(\max)$$
$$= 4.14 \times 10^{-15} \times 7.40 \times 10^{14} - 1.41$$
$$= 1.65 \text{ eV}$$

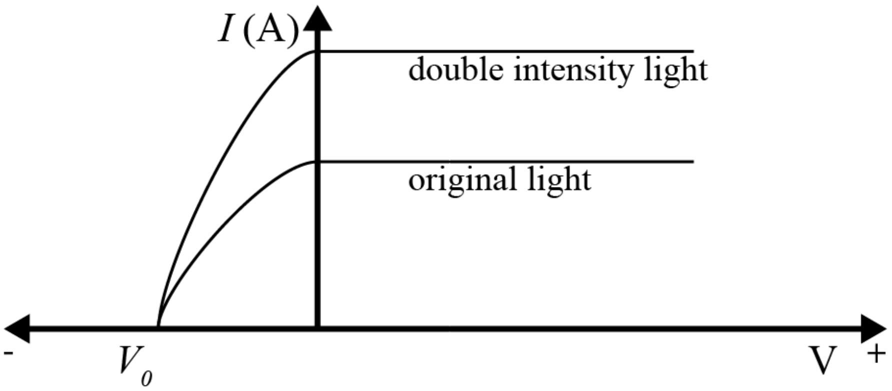
1.65 eV

Mark allocation: 2 marks

- 1 mark for the correct values in the equation
- 1 mark for the correct answer

Question 22b.

Worked solution



Mark allocation: 2 marks

- 1 mark for the same stopping voltage V_0
- 1 mark for double the original photocurrent

Question 22c.

Mark allocation: 3 marks

- 1 mark for mentioning that kinetic energy of electrons is related to the frequency of incident light, not intensity
- 1 mark for saying that no current is observed below the threshold frequency, even at very high intensity
- 1 mark for no time delay is observed in the ejection of electrons

END OF CORE STUDIES SOLUTIONS

SECTION B – Detailed studies

Detailed study 1 – Einstein's special relativity

Question 1

Answer is: D

Worked solution

Relative to the riverbank, Ed is moving 4.0 m s^{-1} north and Mike is moving 4.5 m s^{-1} south. If we imagine Mike being stationary (in an inertial frame of reference), then Ed is moving away from him at 8.5 m s^{-1} north.

Question 2

Answer is: A

Worked solution

$$\Delta t' = \frac{\Delta t}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$= \frac{2}{\sqrt{1-(0.99)^2}}$$

$$= 14 \text{ weeks}$$

Question 3

Answer is: B

Worked solution

Prior to the experiment, it was assumed that light would travel at difference speeds in different directions due to the relative motion of the Earth through the aether. The null result disproved this.

Question 4

Answer is: D

Worked solution

$$m = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$= \frac{1.67\times10^{-27}}{\sqrt{1-0.97^2}}$$

$$= 6.87\times10^{-27} \text{ kg}$$

Question 5

Answer is: C

Worked solution

$$\Delta E_{\text{k}} = \Delta\gamma m_0 c^2$$

$$= \left(\frac{1}{\sqrt{1-0.96^2}} - \frac{1}{\sqrt{1-0.95^2}} \right) \times 1.67 \times 10^{-27} \times \left(3.0 \times 10^8\right)^2$$

$$= 5.544 \times 10^{-11} \text{ J}$$

Convert to eV:

$$\frac{5.544 \times 10^{-11}}{1.6 \times 10^{-19}} = 3.47 \times 10^8 \text{ eV}$$

Question 6

Answer is: A

Worked solution

From the perspective of a stationary observer on Earth, 1 year and 1 second will pass in the time it takes for exactly 1 year to pass on the spaceship.

$$t = 365.25 \times 24 \times 60 \times 60 + 1$$

$$= 31\,557\,601$$

$$t_0 = 365.25 \times 24 \times 60 \times 60$$

$$= 31\,556\,700$$

$$\gamma = \frac{t}{t_0}$$

$$\gamma = \frac{31\,557\,601}{31\,556\,700}$$

$$= 1.000\,000\,032$$

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = 1.000\,000\,032$$

$$v = 75\,524 \text{ m s}^{-1}$$

Question 7

Answer is: C

Worked solution

Both time dilation and length contraction apply to near relativistic speeds. Both a reduction in length and a dilation of time will reduce velocity as $v = \frac{\Delta x}{\Delta t}$.

Question 8

Answer is: B

Worked solution

From Adam's perspective, Charlotte is moving *away* from the source of flash 1 and *towards* the source of flash 2; therefore, flash 1 needs more time to reach Charlotte than flash 2. Adam will see flash 1 occur first.

Tip

- *Note that there is no correct perspective on whether the events were simultaneous or not. Since there is no absolute time or stationary frame of reference, Charlotte's observations are just as correct as Adam's although they will never agree on whether the flashes occurred at the same time or not.*

Question 9

Answer is: B

Worked solution

Time is passing four times slower in the moving particle's frame of reference compared with the stationary observer's frame of reference.

$$\Delta t = \gamma \Delta t_0$$

$$\Delta t = 4\Delta t_0$$

$$4 = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$\frac{1}{16} = 1-\left(\frac{v}{3.0\times 10^8}\right)^2$$

$$\sqrt{\frac{15}{16}} = \frac{v}{3.0\times 10^8}$$

$$v = 0.968\times 3.0\times 10^8$$

$$= 2.9\times 10^8 \text{ m s}^{-1}$$

Question 10

Answer is: D

Worked solution

$E = \Delta mc^2$

$17.6 \times 1.6 \times 10^{-19} = \Delta m \times \left(3.0 \times 10^8\right)^2$

$\Delta m = 3.1 \times 10^{-29}$ kg

Question 11

Answer is: B

Worked solution

It takes more energy to bind the tritium and deuterium nuclei than is needed to bind a single helium nuclei. The remaining energy is released. This appears as a reduction in mass of the nuclei because, as Einstein showed, mass and energy are equivalent. No matter is destroyed in this process but the mass is reduced.

Detailed study 2 – Materials and their use in structures

Question 1

Answer is: D

Worked solution

Ductility is a measure of a material's ability to be drawn into a wire. The large plastic region on the graph indicates that Steel B is more ductile than Steel A.

Question 2

Answer is: C

Worked solution

Toughness is a measure of how much energy a material can absorb before failure. The area under a stress–strain graph is energy per volume (J m^{-3}) and is used to measure toughness.

Question 3

Answer is: B

Worked solution

$$E = \frac{\sigma}{\varepsilon}$$
$$= \frac{125 \times 10^{6}}{1.0 \times 10^{-4}}$$
$$= 1.25 \times 10^{12} \text{ Pa}$$

Question 4

Answer is: A

Worked solution

$$\sigma = \frac{F}{A}$$
$$= \frac{4900}{\pi \times 0.005^{2}}$$
$$= 6.24 \times 10^{7} \text{ or } 62.4 \text{ MPa}$$
$$\varepsilon = 1.25 \times 10^{-4} \text{ (from graph)}$$
$$\varepsilon = \frac{\Delta l}{l}$$
$$1.25 \times 10^{-4} = \frac{\Delta l}{6000}$$
$$\Delta l = 1.25 \times 10^{-4} \times 6000$$
$$= 0.75 \text{ m}$$

Question 5

Answer is: C

Worked solution

The area under the graph gives the energy per volume, or J m^{-3}. When multiplied by the cross-sectional area, it gives the energy per linear metre.

$$\begin{aligned}\text{Area} &= \frac{1}{2} \times 1.5 \times 10^{-4} \times 75 \times 10^{6} \\ &= 5625 \text{ J m}^{-3}\end{aligned}$$

$$5625 \times 3.1 \times 10^{-4} = 1.7 \text{ J m}^{-1}$$

Hence, 1.7 J of energy is stored in each metre of steel.

Question 6

Answer is: B

Worked solution

The vertical component of the tension force is equal and opposite to the weight force of the beam.

$$\sin 35° = \frac{mg}{T}$$

$$\begin{aligned}T &= \frac{1200}{\sin 35°} \\ &= 2092 \text{ N}\end{aligned}$$

Question 7

Answer is: C

Worked solution

By considering only the horizontal forces acting, it can be shown that the force of the wall on the beam is equal to the horizontal component of the tension force.

$$\tan 35° = \frac{1200}{F_{\text{wb}}}$$

$$\begin{aligned}F_{\text{wb}} &= \frac{1200}{\tan 35°} \\ &= 1713 \text{ N}\end{aligned}$$

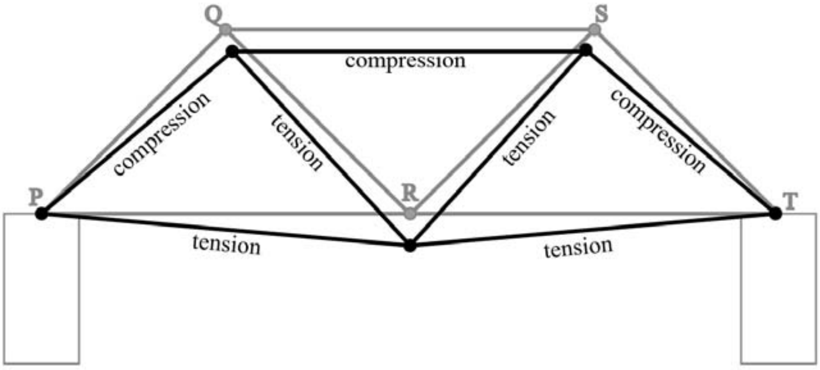
The horizontal component of the tension force acts to the left, so the reaction force from the wall must act to the right.

Question 8

Answer is: B

Worked solution

Imagine how the structure would behave if it were to deform (shown below). Members that would lengthen are under tension and those that would get shorter are under compression.



Question 9

Answer is: D

Worked solution

Use rotational equilibrium to find the first force, using pillar A as the point of rotation:

$$F_B \times 12 = 12\,000 \times 6 + 10\,000 \times 9$$

$$F_B = \frac{162\,000}{12}$$

$$= 13\,500 \text{ N}$$

Use translational equilibrium to find F_A:

$$F_A + F_B = 12\,000 + 10\,000$$

$$F_A = 22\,000 - 13\,500$$

$$= 8500 \text{ N}$$

Question 10

Answer is: C

Worked solution

Steel is strong under tension, whereas concrete is relative weak under tension. The steel reinforcing is placed where the concrete is under tension.

Question 11

Answer is: A

Worked solution

Concrete and stone are strong under compression but weak under tension. When placed in an arch, all the stone blocks are under compression and none is under tension.

Detailed study 3 – Further electronics

Question 1

Answer is: B

Worked solution

$$f = \frac{1}{10\times10^{-3}}$$
$$= 50 \text{ Hz}$$
$$V_{\text{RMS}} = \frac{V_{\text{peak}}}{\sqrt{2}}$$
$$= \frac{30}{\sqrt{2}}$$
$$= 21 \text{ V}_{\text{RMS}}$$

Question 2

Answer is: D

Worked solution

The ratio of V_{primary}:$V_{\text{secondary}}$ is equal to the ratio to N_{primary}:$N_{\text{secondary}}$.
A 240:8 ratio simplifies to 30:1.
7200:240 also simplifies to 30:1.

Question 3

Answer is: C

Worked solution

At the breakdown voltage of 3.0 V, 2 mA flows through the diode. For this to happen, 6.0 V must drop over the resistor. Use Ohm's law to find the value of the resistor.

$$V = IR$$
$$R = \frac{6}{2\times10^{-3}}$$
$$= 3000\ \Omega$$

Question 4

Answer is: D

Worked solution

When the lower of the two AC terminals is positive, the current can flow through either B or D, which means there is no potential difference between the two DC terminals.

Question 5

Answer is: A

Worked solution

The current is always passing through two diodes. Convert 16 V peak to RMS and subtract twice the threshold voltage of the diodes.

$$\frac{16}{\sqrt{2}} - 2 \times 0.75 = 9.81 \text{ V}$$

Question 6

Answer is: A

Worked solution

Capacitor Y must be significantly larger than capacitor X as it provides much greater smoothing.
In option A., 0.6 μF = 600 nF, which is 20 times larger than 30 nF.

Question 7

Answer is: C

Worked solution

It takes approximately 15 ms for the capacitor to discharge to 37% of its maximum capacity.

$$\tau = RC$$

$$C = \frac{0.015}{300}$$

$$= 5.0 \times 10^{-5} \text{ F}$$

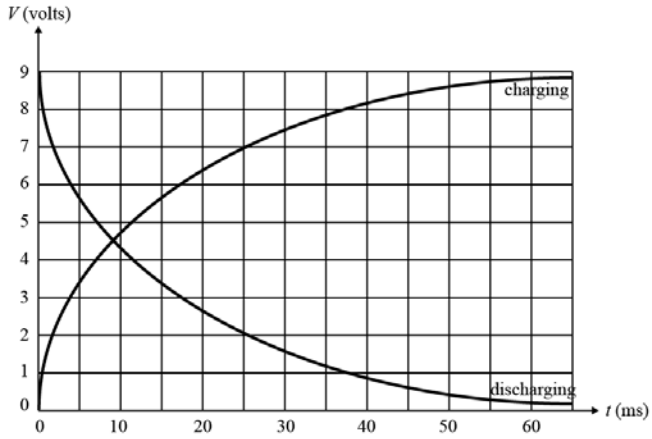
$$= 50\ \mu\text{F}$$

Question 8

Answer is: A

Worked solution

During a charging cycle, the graph from Figure 6b can presumed to be inverted as shown below.



At 25 ms, the capacitor has a potential difference of 7.0 V, which means the resistor has 2.0 V across it.

$$V = IR$$

$$I = \frac{2}{300}$$
$$= 0.0067 \text{ A}$$

Question 9

Answer is: D

Worked solution

Main power in Australia is 240 V RMS, which can be converted to the following quantities:

$$240 \times \sqrt{2} = 340 \text{ V}_{\text{peak}}$$

$$240 \times 2\sqrt{2} = 680 \text{ V}_{\text{peak–peak}}$$

Question 10

Answer is: B

Worked solution

Voltage regulators reduce the input voltage to produce a smooth output voltage. An input voltage of 2 V to 3 V more than the desired output should be used. Any excess electrical energy will be dissipated as heat.

Question 11

Answer is: C

Worked solution

A voltmeter measures the difference in electrical potential energy (potential difference) between two points on the circuit. It does this when placed in parallel to the device it is being used to measure. For the meter to not interfere with the circuit, voltmeters must have very high resistance.

Ammeters measure the amount of current that flows through them and must be placed in series with the components. They must have very low resistance to not interfere with the circuit.

Detailed study 4 – Synchrotron and its applications

Question 1

Answer is: A

Worked solution

$$\frac{1}{2}mv^2 = q\Delta V$$

$$\frac{1}{2}\times 9.1\times 10^{-31}\times\left(5.6\times 10^7\right)^2 = 1.6\times 10^{-19}\times\Delta V$$

$$\Delta V = \frac{\frac{1}{2}\times 9.1\times 10^{-31}\times\left(5.6\times 10^7\right)^2}{1.6\times 10^{-19}}$$

$$= 8918 \text{ V}$$

Question 2

Answer is: B

Worked solution

$$r = \frac{mv}{qB}$$

$$= \frac{9.1\times 10^{-31}\times 5.6\times 10^7}{1.6\times 10^{-19}\times 4.8\times 10^{-5}}$$

$$= 6.6 \text{ m}$$

By the left-hand slap rule, the direction of the force will be in direction A.

Tip

- *When using the right-hand slap rule, your thumb points in the direction of conventional current, the direction that a positive charge would move. When analysing the motion of electrons, either reverse the direction of your thumb or use your left hand.*

Question 3

Answer is: C

Worked solution

Reducing the voltage by a factor of four will reduce the velocity of the electrons by half because $q\Delta V = \frac{1}{2}mv^2$ or $v = \sqrt{\frac{2q\Delta V}{m}}$. The force on the electrons is directly proportional to their velocity by $F = qvB$. Therefore, halving the velocity will halve the force.

Question 4

Answer is: C

Worked solution

Electrons are initially released from the electron gun before being accelerated further by the linac. The booster ring increases their velocity even more before the electrons are sent to the storage ring. The light from the electrons travels down a beamline, through an optics room and into an experiment room.

Question 5

Answer is: B

Worked solution

Pulses of electrons from the electron gun are synchronised with pulses of radio frequency radiation, which accelerate the electrons in bunches. The electrons are carried on moving waves of radiation.

Question 6

Answer is: D

Worked solution

The booster ring uses pulses of radio frequency radiation to accelerate the electrons to close to the speed of light. Option A describes the operation of the storage ring, B describes the electron gun and C describes the optics room.

Question 7

Answer is: B

Worked solution

Wigglers increase the intensity of a wide spectrum of radiation by inducing rapid changes in direction. The resulting light is incoherent but very intense.

Question 8

Answer is: A

Worked solution

Compton scattering occurs when a photon collides with an electron and loses some of it energy. The electron and the photon demonstrate conservation of momentum.

Question 9

Answer is: A

Worked solution

Photons scattered at a larger angle lose more of their energy and so increase in wavelength.

Question 10

Answer is: C

Worked solution

$$2d\sin\theta = n\lambda,\ n = 1$$

$$\begin{aligned} d &= \frac{\lambda}{2\sin\theta} \\ &= \frac{130\times10^{-12}}{2\sin 11.9^\circ} \\ &= 3.15\times10^{-10}\ \text{m} \end{aligned}$$

Question 11

Answer is: C

Worked solution

From Bragg's law:

$$\theta_n = \sin^{-1}\left(\frac{n\lambda}{2d}\right)$$

$$\theta_2 = \sin^{-1}\left(\frac{2\times130\times10^{-12}}{2\times5.1\times10^{-10}}\right) = 14.8^\circ$$

$$\theta_3 = \sin^{-1}\left(\frac{3\times130\times10^{-12}}{2\times5.1\times10^{-10}}\right) = 22.5^\circ$$

Detailed study 5 – Photonics

Question 1

Answer is: C

Worked solution

Atoms are electrically excited and the radiation emitted when excited electrons transition back to the ground state is used to make visible light.

Question 2

Answer is: A

Worked solution

$$\Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{4.14\times10^{-15}\times3.0\times10^{8}}{1.91}$$

$$= 6.50\times10^{-7} \text{ m or } 650 \text{ nm}$$

Question 3

Answer is: B

Worked solution

Population inversion is required in the meta-stable excited state so that photons can stimulate emission of similar photons by triggering a transition to the ground state.

Question 4

Answer is: B

Worked solution

Total internal reflection requires light to be bent away from the normal as it moves into a less optically dense medium. The only listed transition for which this is true is glass to water.

Tips

- To confirm, calculate the critical angle for the transition:

$$i_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

$$= \sin^{-1}\left(\frac{1.33}{1.5}\right)$$

$$= 62.5°$$

- Attempting this calculation with the other listed transitions will give an error.

Question 5

Answer is: A

Worked solution

A smaller difference in refractive indices will mean a larger critical angle and fewer modes will propagate along the fibre.

Question 6

Answer is: C

Worked solution

Modal dispersion refers to pulses that begin their journey down the fibre together gradually getting spread out (dispersed) because they reflect off the core/cladding interface at different angles (modes). Graded-index fibres are designed so that all modes travel at the same speed.

Question 7

Answer is: A

Worked solution

The angle of acceptance (θ_1) is the maximum angle at which a ray can enter an optical fibre and undergo total internal reflection.

$$n_{\text{external}} \sin\theta_1 = \sqrt{n_{\text{core}}^2 - n_{\text{cladding}}^2}$$

$$\theta_1 = \sin^{-1}\left(\sqrt{1.45^2 - 1.42^2}\right)$$

$$= 17.1°$$

Therefore, only angles less than 17.1° will allow total internal reflection.

Question 8

Answer is: C

Worked solution

The minimum value for θ_B is the critical angle, i_c.

$$i_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

$$= \sin^{-1}\left(\frac{1.42}{1.45}\right)$$

$$= 78.3°$$

So only angles larger than 78° will undergo total internal reflection.

Question 9

Answer is: B

Worked solution

$$\Delta P(\text{dB}) = -10\log\left(\frac{P_{\text{in}}}{P_{\text{out}}}\right)$$

$$-0.56 \times 3.5 = -10\log\left(\frac{0.015}{P_{\text{out}}}\right)$$

$$0.196 = \log\left(\frac{0.015}{P_{\text{out}}}\right)$$

$$10^{0.196} = \frac{0.015}{P_{\text{out}}}$$

$$P_{\text{out}} = 0.00\,955\ \text{W}$$

Question 10

Answer is: A

Worked solution

Tiny variations of density in the glass are present from the time it is manufactured. The scattering of light due to this effect is known as Rayleigh scattering.

Tip

- *Option B describes bending losses; option D describes modal dispersion.*

Question 11

Answer is: D

Worked solution

Laser diodes emit light over a range of 2 nm compared with the 30 nm to 40 nm for LEDs. This helps laser diode light reduce material dispersion and pulse spreading.

Detailed study 6 – Sound

Question 1

Answer is: C

Worked solution

The loudest frequency will be the fundamental frequency, which on a fixed string has a wavelength of twice the string length.

$$v = f\lambda$$

$$f = \frac{145}{2 \times 0.66}$$
$$= 110 \text{ Hz}$$

Question 2

Answer is: A

Worked solution

By halving the wavelength, the frequency is doubled. The original frequency is double the new frequency.

Question 3

Answer is: A

Worked solution

$$L(\text{dB}) = 10\log\left(\frac{I}{I_0}\right)$$

$$84 = 10\log\left(\frac{I}{10^{-12}}\right)$$

$$10^{8.4} = \frac{I}{10^{-12}}$$

$$I = 10^{8.4-12} = 2.5 \times 10^{-4} \text{ W m}^{-2}$$

Question 4

Answer is: D

Worked solution

On the decibel scale, a halving of intensity corresponds with a difference of approximately 3 dB. It can be proven as shown:

$$\begin{aligned}\Delta L &= 10\log\left(\frac{I}{I_0}\right)\\ &= 10\log\left(\frac{2I}{I}\right)\\ &= 3.01\end{aligned}$$

Question 5

Answer is: B

Worked solution

Phon lines are lines of equivalent loudness. Jack hears all points on the 50 phon line as being 50 dB.

Question 6

Answer is: B

Worked solution

The low points on the phon curves indicate high sensitivity to those frequencies.

Question 7

Answer is: D

Worked solution

The velocity microphone relies on electromagnetic induction to create a signal voltage. It is similar to a moving coil or dynamic microphone but is more directional due to its construction.

Question 8

Answer is: D

Worked solution

A glass bottle can be modelled as a closed tube. Only odd number harmonics are possible in a closed tube. Above the fundamental (240 Hz) are the 3rd, 5th, 7th etc. harmonics.

$240 \times 5 = 1200$ Hz

Question 9

Answer is: B

Worked solution

A flat response curve is ideal for high fidelity sound reproduction. The tweeter requires a flat line in high frequencies, the squawker requires a flat line in the mid-range and the woofer needs a flat curve in low frequencies.

Question 10

Answer is: B

Worked solution

The sound that reaches the microphone must diffract around the corner. The extent of diffraction is proportional to the ratio $\frac{\lambda}{w}$. Low frequencies correspond to larger wavelengths and these tones will be heard more strongly in the microphone.

Question 11

Answer is: D

Worked solution

Enclosures are designed to prevent destructive interference. Without them, a compression from the rear of the cone could interfere with a rarefaction from the front of the cone, reducing fidelity.

END OF DETAILED STUDIES SOLUTIONS