Answer

SPM MODEL PAPER

Paper 1

1 B

2 A

$v^2 = u^2 + 2as$
$= 0^2 + 2(10)(12)$
$v = \sqrt{240}$
$= 15.5 \text{ m s}^{-1}$

3 C

4 D

$a = \frac{10 - 0}{10 - 12}$
$= -5 \text{ m s}^{-2}$
$\therefore$ Deceleration $= 5 \text{ m s}^{-2}$

5 C

When the impact time is extended, the impulse force decreases.

6 B

The apple experiences a gravitational acceleration, g.
$F = ma$
$= mg$
$\neq 0$

7 D

$F = ma$
$12 - G = 4(0)$
$G = 12 \text{ N}$

8 A

9 C

$a = \frac{v^2}{R}$
$= \frac{\left(\frac{2\pi R}{T}\right)^2}{R}$
$= \frac{4\pi R}{T^2}$

10 A

$$\frac{\frac{\cancel{GMm}}{(3.8 \times 10^6 + 6.4 \times 10^6)^2}}{\frac{\cancel{GMm}}{(6.4 \times 10^6)^2}} = \frac{(6.4 \times 10^6)^2}{(1.02 \times 10^7)^2}$$
$= 0.39$

11 B

The temperature does not change when the specific latent heat of fusion is absorbed.

12 C

$Q = mc\theta$
$Pt = mc\theta$
$c = \frac{Pt}{m\theta}$
$= \frac{800 \times 4 \times 60}{1.2 \times 26}$
$= 6153.8$
$\approx 6154 \text{ J kg–1 °C}^{-1}$

13 C

14 D

15 B

16 B

$\lambda = \frac{ax}{D}$
$x = \frac{D\lambda}{a}$
$= \frac{2.5 \times 6 \times 10^{-7}}{0.3 \times 10^{-3}}$
$= 5 \times 10^{-3} \text{ m}$
$= 5 \text{ mm}$
$\therefore$ The distance between successive bright edges to dark edges
$= 5 \div 2$
$= 2.5 \text{ mm}$

17 A

18 D

$n = \frac{1}{\sin c}$
$= \frac{1}{\sin 50°}$
$= 1.31$

19 D

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$
$\frac{1}{u} + \frac{1}{-8} = \frac{1}{25}$
$\frac{1}{u} = \frac{17}{200}$
$u = 11.8 \text{ cm}$

20 C

$P = \frac{W}{t}$
$= \frac{43 \times 10 \times 5}{50}$
$= 35.8 \text{ W}$

21 B

Diagram 5.1: Extension of each spring $= 16 - 12$
$= 4 \text{ cm}$
$F = kx$
$k = \frac{5 \text{ N}}{4 \text{ cm}}$
$= 1.25 \text{ N cm}^{-1}$

Diagram 5.2: X and Y:
$F = kx$
$1.25 = 1.25x$
$x = 1 \text{ cm}$

Z:
$F = kx$
$2.5 = 1.25x$
$x = 2 \text{ cm}$

$\therefore P = (12 + 1) + (12 + 2)$
$= 27 \text{ cm}$

22 A

Atmospheric pressure $= 76 - 62$
$= 14 \text{ cm Hg}$

23 A

$P_1 = 720 \text{ mm Hg}$, $V_1 = 150 \text{ cm}^3$
$P_2 = 800 \text{ mm Hg}$, $V_2 = ?$
$P_1V_1 = P_2V_2$
$V_2 = \frac{P_1V_1}{P_2}$
$= \frac{(720)(150)}{800}$
$= 135 \text{ cm}^3$

24 C

25 D

$V = IR$

$= 0.5 \times 4$

$= 2$ V

26 D

27 B

$V = IR$

$R = \frac{V}{I}$

$= \frac{240}{2}$

$= 120\ \Omega$

$P = \frac{V^2_{source}}{R}$

$= \frac{110^2}{120}$

$= 100.8$ W

28 C

The magnitude of the potential difference is doubled.
The frequency is doubled while the duration is halved.

29 B

$P_i = 320$ W

$P_o = \frac{Q}{t}$

$= \frac{mc\theta}{t}$

$= \frac{0.6 \times 4200 \times (25 - 20)}{3 \times 60}$

$= 70$ W

Efficiency $= \frac{P_o}{P_i} \times 100\%$

$= \frac{70}{320} \times 100\%$

$= 21.9\%$

30 A

$\frac{N_P}{N_S} = \frac{V_P}{V_S}$

$= \frac{240}{10}$

$= 24$

31 D

The current is parallel to the magnetic field lines.
So, there is no magnetic flux cutting.

32 B

According to Lenz's Law, *X* will be the south pole to oppose the magnetic motion. So, the electric current will flow clockwise when observed from the end *X*. The galvanometer pointer is deflected to the right.

33 B

34 C

35 C

Nucleon number $Q = 234 + 0 = 234$
Proton number $Q = 92 - 1 = 91$
Number of protons $= 91$
Number of neutrons $= 234 - 91 = 143$

36 D

$100\% \xrightarrow{T_{\frac{1}{2}}} 50\% \xrightarrow{T_{\frac{1}{2}}} 25\% \xrightarrow{T_{\frac{1}{2}}} 12.5\% \xrightarrow{T_{\frac{1}{2}}} 6.25\%$

$4T_{\frac{1}{2}} = 100$

$T_{\frac{1}{2}} = 25$ minutes

37 A

$E = mc^2$

$m = \frac{E}{c^2}$

$= \frac{3.12 \times 10^{-13}}{(3.0 \times 10^8)^2}$

$= 3.47 \times 10^{-30}$ kg

38 A

$E = hf$

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

$E \propto \frac{1}{\lambda}$

39 B

$P = nhf$

$n = \frac{P}{hf}$

$= \frac{60}{6.63 \times 10^{-34} \times 5.2 \times 10^{14}}$

$= 1.74 \times 10^{20}$

40 D

$TK_{max} = hf - W$

$\frac{1}{2}mv^2 = hf - W$

$\frac{1}{2}(9.11 \times 10^{-31})v^2 = 3.46 \times 10^{-10} - 2.1 \times 10^{-20}$

$v^2 = 2.99 \times 10^{10}$

$v = 1.73 \times 10^5\ \text{m}^{\text{ s}-1}$

Paper 2

Section A

1

1.74
7.15×10^7
8.85×10^3
1.1×10^{-4}

2 (a) Liquid

(b) $Q = mc\theta$

$Pt = mc\theta$

$c = \frac{Pt}{m\theta}$

$= \frac{(300)(4 \times 60)}{(2.0)(86 - 28)}$

$= 620.69$ J kg^{-1} °C^{-1}

(c) $Q = ml$

$Pt = ml$

$l = \frac{Pt}{m}$

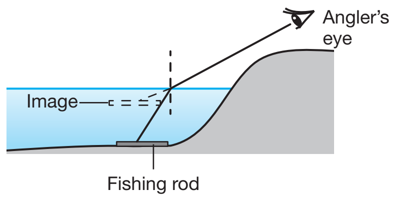
$= \frac{(300)(5 \times 60)}{2.0}$

$= 1.8 \times 10^4$ J kg^{-1}

3 (a) Refraction of light

(b) When the light from the rod moves from water which is a denser medium to air which is a less dense medium, the light is refracted away from the normal. The angler's eyes saw the light that arrived as if it was coming and a position closer to the surface of the lake.

(c)



(d) $n = \frac{D}{d}$

$1.33 = \frac{2.2}{d}$

$d = 1.65$ m

4 (a) $\frac{1}{2}\times(14+7)\times15=157.5$ m

(b) $11-4=7$ s

(c) $a=\frac{15-0}{11-14}$
$=-5$ m s^{-2}
Deceleration = 5 m s^{-2}

(d) Average speed $=\frac{157.5\text{ m}}{14\text{ s}}$
$=11.3$ m s^{-1}

5 (a) Series

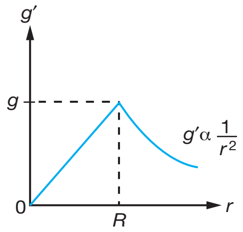
(b) (i) The number of bulbs in Figure 5 is more than Figure 6.
(ii) The ammeter reading in Figure 6 is higher than Figure 5.
(iii) The greater the number of bulbs, the lower the ammeter reading.

(c) A larger number of bulbs in Figure 5 results in a larger effective resistance value. Therefore, the current flowing through the circuit is smaller.

(d) A large number of bulbs in a series arrangement produces a greater effective resistance and thus causes a smaller current to flow in the circuit.

(e) (i) X
(ii) The current flowing through X is greater than the current flowing through Y and Z.

6 (a)



(b) Based on the Principle of Conservation of Energy,
Loss of kinetic energy = Increase in potential energy on Earth,

$\frac{1}{2}mv^2=mgx$

On planet P,

$\frac{1}{2}mv^2=mg'x'$

$mgx=mg'x'$

$\frac{x'}{x}=\frac{g}{g'}$ ——— ①

From $g=\frac{GM}{r^2}=\frac{G\left(\frac{4}{3}\pi r^3\rho\right)}{r^2}$

$g=\frac{4}{3}\pi Gr\rho$ ——— ②

and $g'=\frac{4}{3}\pi Gr'\rho'$ ——— ③

Replace ②, and ③ into ①,

$\frac{x'}{x}=\frac{\frac{4}{3}\pi Gr\rho}{\frac{4}{3}\pi Gr'\rho'}$

$\frac{x'}{x}=\frac{r\rho}{r'\rho'}$

(c) $g\propto\frac{1}{r^2}$

$\therefore \frac{g'}{g}=\frac{r^2}{r'^2}\Rightarrow g'=\frac{r^2}{r'^2}g$

Percentage reduce $=\frac{g-g'}{g}\times100\%$

$=\frac{g-\frac{r^2}{r'^2}g}{g}\times100\%$

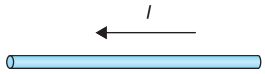
$=\left(1-\frac{r^2}{r'^2}\right)\times100\%$

$=\left(1-\frac{6370^2}{(6370+180^2)}\right)\times100\%$

$=5.4\%$

7 (a) (i) Areas where magnetic materials experience magnetic forces.
(ii) The passage of permanent magnetic field or temporary magnetic field from the north pole to the south pole.

(b)

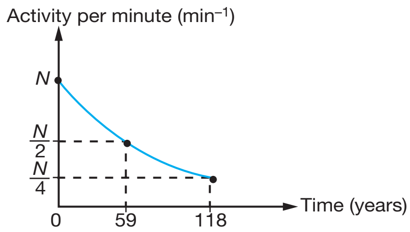


(c) (i) The copper rod moves towards the magnet (or into the paper).
(ii) Fleming's Left Hand Rule

(d) (i) The rod moves away from the magnet (or out of the paper)
(ii) The rod moves away from the magnet (or out of the paper)
(iii) The rod moves towards the magnet with greater acceleration.

(e) (i) The rod moves towards the magnet with greater acceleration
(ii) The resistance of the copper rod decreases as the diameter increases. The force on the rod increases.

8 (a) (i) Beta particles
(ii) Beta particles can penetrate metal sheets. Alpha particles cannot penetrate metal sheets while gamma rays have high penetrating power. Therefore, gamma rays always penetrate metal sheets of various thicknesses.
(iii) Long half-life.
(iv) The radioactive source does not need to be replaced frequently.
(v) Strontium-90
(vi)

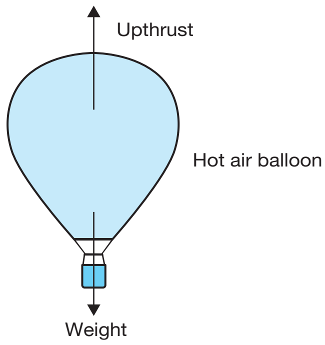


(b) (i) Nuclear fusion
(ii) $2(2.0140)-3.01493-1.00867=0.0046$ amu
$E=mc^2$
$=(0.0046\times1.60\times10^{-27})\times(3.0\times10^8)^2$
$=6.8724\times10^{-13}$ J
(iii) The products of nuclear fusion are non-radioactive.

Section B

9 (a) (i) Archimedes principle.
An object partially or completely immersed in a fluid will experience an upward thrust equal in magnitude to the weight of the fluid displaced by the object.

(ii)



The air inside the balloon is heated by a gas burner. This causes the air to expand and a large volume of surrounding air is displaced. At the same time, hot air has a lower density than the surrounding air. When the upward thrust exceeds the weight of the balloon, the balloon will move upwards. The higher the balloon, the less dense the air around it. The balloon will be stationary when the upward thrust is equal to the weight of the balloon. The balloon will descend when the upward thrust is less than the weight of the balloon. Therefore, the height of the balloon can be controlled by adjusting the temperature of the air inside the balloon.

(b) (i) Mass of displaced water $= 1 \times (9 \times 2)$
$= 18$ g
Mass of lead shots $= 18 - 14$
$= 4$ g

(ii) Volume of displaced water $= \frac{18}{1.30}$
$= 13.8 \text{ cm}^3$
Length of immersed tube $= \frac{13.8}{2}$
$= 6.9$ cm

(iii) The density of the liquid is minimum when the entire 12 cm long tube is submerged.
Mass of displaced liquid = 18 g
$18 = \rho \times 12 \times 2$
$\rho = 0.75 \text{ g cm}^{-3}$

10 (a) The process of inserting a small, controlled number of impurities into the lattice of a pure semiconductor crystal.

(b)

Material	Conductivity
Conductor	Height
Insulation	None
Semiconductor	Low at low temperature, high at high temperature.

(c)

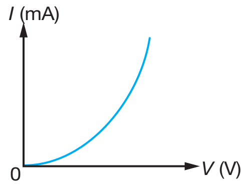
	Majority charge carriers	Minority charge carriers
Semiconductor type-*p*	Hollow	Free electrons
Semiconductor type-*n*	Free electrons	Hollow

(d)

Appropriate features	Reason
A substance with 4 valence electrons	Pentavalent or trivalent elements can be easily doped into them to form *p* type or *n* type semiconductors
Highest melting point	So that the material does not melt at high temperatures
Solid state	Materials can be easily formed into various types of components
Resistivity at room temperature	Current can flow through it easily
Material *C* is the most suitable	Because it has 4 valence electrons, its highest melting point, in the solid state and low resistivity at room temperature

(e) (i) A diode only allows current to flow in one direction only

(ii)



Section C

11 (a) (i) Equation: Both waves are transverse waves.
Difference: Water waves travel at a very low speed while light waves travel at a speed of $3.0 \times 10^8 \text{ m s}^{-1}$ in a vacuum.

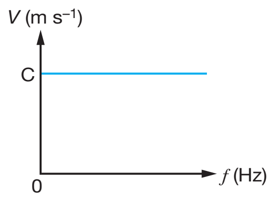
(ii)
- Light travels from water to air while water waves travel from deep water to shallow water.
- The wavelength of light increases while the wavelength of water decreases but the frequency does not change.
- Light is refracted away from the normal line when exiting the surface of the water while water waves are refracted closer to the normal when entering the shallow water area.
- The speed of light increases while the speed of water waves decreases.
- Physics concepts: Refraction of waves

(b) (i) A wave consisting of a magnetic field and an electric field that are perpendicular to each other.

(ii) The wavelength is inversely proportional to the frequency of the wave.

(iii)
- Is a transverse wave.
- It travels in a vacuum at the speed of light.
- Can propagate through vacuum.
- Experience the phenomena of reflection, refraction, diffraction, interference and polarization.

(iv)



(c) (i) $\lambda = \frac{330}{480}$
$= 0.06875$ m

(ii) $a = 2.0$ m, $\lambda = 0.6875$ m, $D = 4$ m
$\lambda = \frac{ax}{D}$
$x = \frac{D\lambda}{a}$
$= \frac{4 \times 0.6875}{2.0}$
$= 1.375$ m