JAWAPAN

BAB 1

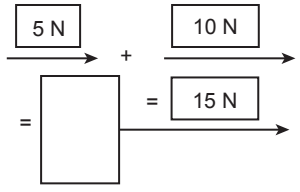
Daya dan Gerakan II
Force and Motion II

1.1 Daya Paduan
Resultant Force

1. Daya paduan / *resultant force*

2. (a)

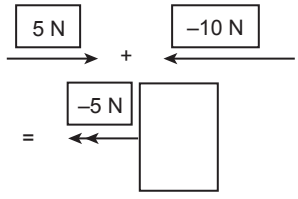
Penambahan vektor
Vector addition



– F = 15 N
– Arah: dalam arah tindakan daya (ke arah kanan)
Direction: in the direction of acting force (to the right)

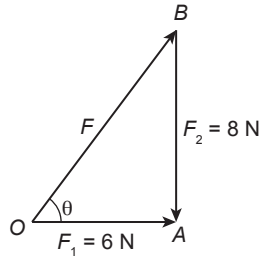
(b)

Penolakan vektor
Vector subtraction



– F = –5 N
– Arah: dalam arah tindakan daya 10 N (ke arah kiri)
Direction: in the direction of acting force 10 N *(to the left)*

(c)



teorem Pythagoras / *theorem Pythagoras*

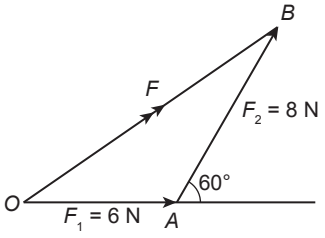
$F = \sqrt{6^2 + 8^2}$ = 10 N

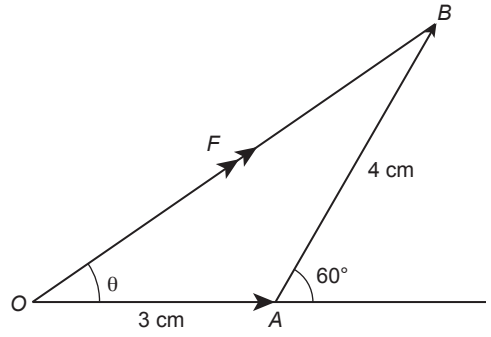
Arah / *Direction*

$\tan\theta = \frac{8}{6}$

$\theta = \tan^{-1}\left(\frac{8}{6}\right) = 53.1^\circ$

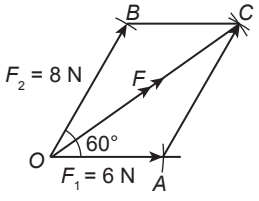
(d)

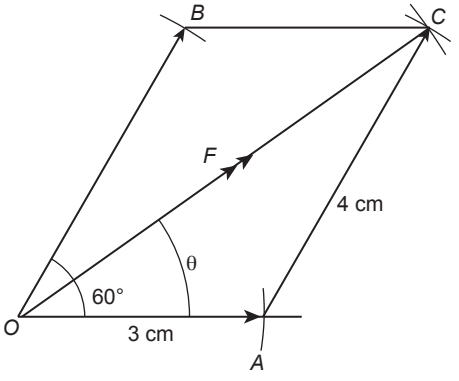




OB : 6.1 cm
F = 6.1 × 2 N
= 12.2 N

Arah / *Direction*, $\theta = 35^\circ$





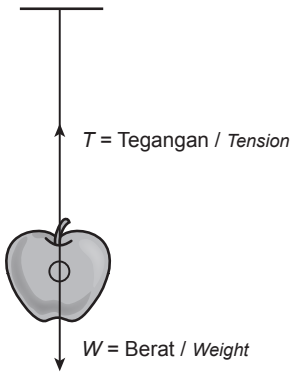
OC : 6.1 cm
$F = 6.1 \times 2$ N
$= 12.2$ N

Arah / *Direction,* $\theta = 35^{O}$

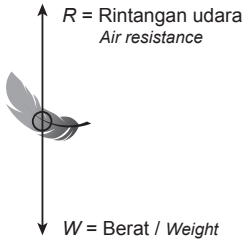
Daya paduan yang bertindak ke atas satu objek dan gambar rajah jasad bebas
Resultant force acting on object and free body diagram

1. daya-daya yang bertindak pada suatu objek
forces acting on an object

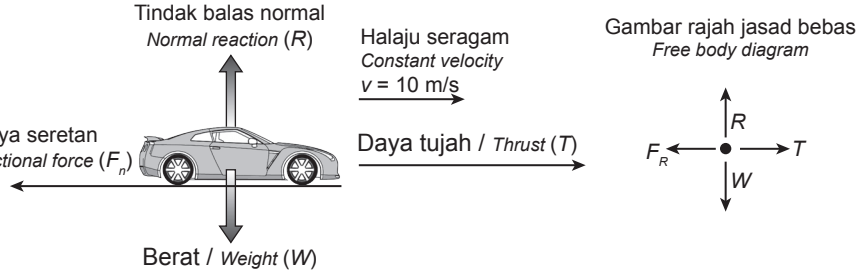
2. (a)



(b)

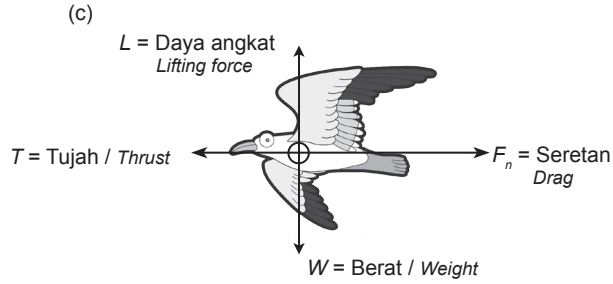


(b)



R = Berat / *Weight* (W)
T = Daya seretan / *Frictional force* (F_R)
$F = T - S = 0$ N
$a = 0$ m s^{-2}
$v = 10$ m s^{-1}.

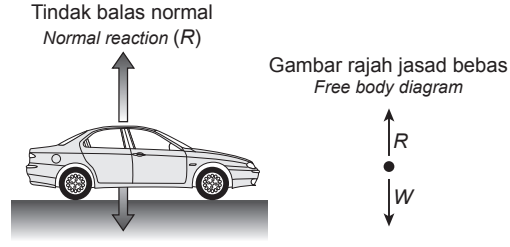
(c)



Daya paduan dan Hukum Gerakan Newton
Resultant force and Newton's Law of Motion

2. sifar , seimbang / *zero , equilibrium*

3. (a)

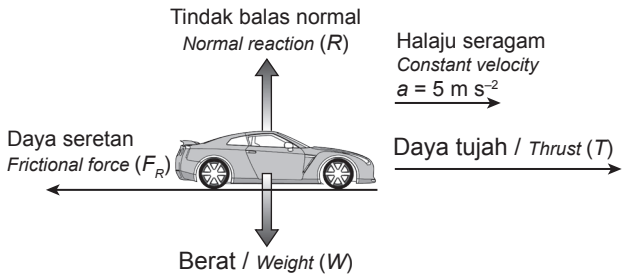


Tindak balas normal / *Normal reaction* (R)
= Berat / *Weight* (W)
$F = W - R = 0$ N
$a = 0$ m s^{-2}
$v = 0$ m s^{-1}

4. sifar , pegun , halaju seragam
stationary, uniform velocity

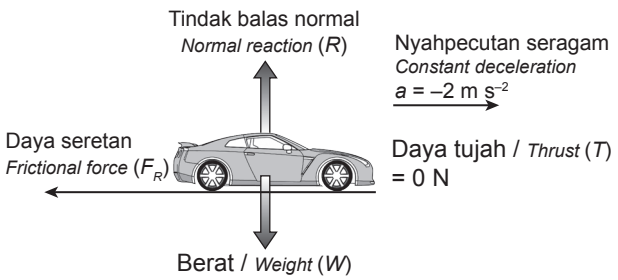
5. (a) pegun , pegun
rest , rest
(b) gerakan , halaju
motion , velocity

6. (c)



R = Berat / *Weight* (W)
$T >$ Daya seretan / *Frictional force* (F_R)
$F = T - F_R > 0$ N
bertambah / *increasing*
$a = 5$ m s^{-2}

(d)

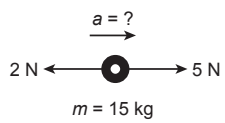


R = Berat / *Weight* (W)
$T = 0$ N
$F = F_R \neq 0$ N
berkurangan / *decreasing*
$a = -2$ m s^{-2}

7. (a) $F \neq 0$ N
(b) $a \neq 0$ m s^{-2}
(c) pegun / *rest*
(d) gerakan / *motion*

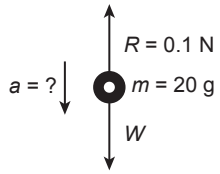
Menyelesaikan masalah yang melibatkan daya paduan (F), jisim (m) dan pecutan (a).
Solving problems involving resultant force (F), mass (m) and acceleration (a)

1. (a)



(b) $F = 5$ N $- 2$ N $= 3$ N
$F = ma$
$3 \text{ N} = 15 \text{ kg} \times a$
$a = \frac{3}{15}$ N kg^{-1}
$= 0.2$ m s^{-2}

2. (a)



(b) $W = \frac{20}{1\,000} \times 10 \text{ N} = 0.2$ N
$F = 0.2 \text{ N} - 0.1 \text{ N} = 0.1$ N
$F = ma$
$0.1 \text{ N} = 0.02 \text{ kg} \times a$
$a = \frac{0.1}{0.02}$ N kg^{-1} $= 5$ m s^{-2}

3. (a) $R = mg + ma$
(b) $R = mg$
(c) $R = mg - ma$
(d) $R = mg - ma$
(e) $R = mg$
(f) $R = mg + ma$

4. (a) Kes I / *Case I*:
$F = T - Mg$
$T - Mg = Ma$

(b) Kes II / *Case II*:
(d) $F = mg - G$
(e) $mg - G = (M + m) \times a$
$a = \frac{mg - G}{(M + m)}$

(f) $F_M = T - G$
$F_m = mg - T$

(g) $T - G = Ma$
$T = Ma + G$
$mg - T = m\,a$
$T = mg - ma$

(h) $a = \frac{mg - G}{(M + m)} = \frac{1.8 \times 9.8 - 5.0}{1.2 + 1.8}$
$= \frac{12.64}{3} = 4.2$ m s^{-2}
$T = 1.2 \times 4.2 + 5.0$
$= 10\ 0$ N
$T = 1.8 \times 9.8 - 1.8 \times 4.2$
$= 10.0$ N

(c) Kes III / *Case III*:
(d) $F = (2 - 1.5)g$
$= 0.5 \times 9.8$
$= 4.9$ N

(e) $4.9 = (3.5) \times a$
$a = \frac{4.9}{3.5} = 1.4$ m s^{-2}

(f) $F = mg - T$

(g) $mg - T = 2 \times 1.4$
$T = 2 \times 9.8 - 2 \times 1.4$
$= 16.8$ N

(h) $F = T - mg$

(i) $T - mg = 1.5 \times 1.4$
$T = 1.5 \times 1.4 + 1.5 \times 9.8$
$= 16.8$ N

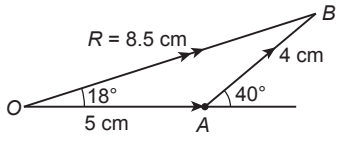
Tugasan 1

1.

$F = 7$ N + 3 N = 10 N	$F = 1$ N + 2 N – 5 N = –2 N (ke arah kiri / *to the left*)	$F = \sqrt{8^2 + 6^2}$ = 10 N Arah / *Direction*: $\theta = \tan^{-1}\frac{6}{8} = 36.9°$ dengan daya ufuk 8 N *with horizontal force* 8 N

2.

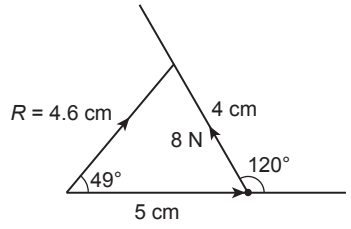
Skala / *Scale:* 1 cm ≡ 1 N



Daya paduan, / *Resultant force,*
$F = 8.5$ cm × 1 N cm^{-1} = 8.5 N

Arah / *Direction,*
$\theta = 18°$ dengan daya ufuk 5 N / *with horizontal force 5 N*

Skala / *Scale:* 1 cm ≡ 2 N



Daya paduan, / *Resultant force,*
$F = 4.6$ cm × 2 N cm^{-1} = 9.2 N

Arah, / *Direction,*
$\theta = 48°$ dengan daya ufuk 10 N / *with horizontal force 10 N*

3. $F = 8$ N
8 N – $G = (2$ kg$)(2$ m s^{-2})
$G = 8$ N – 4 N = 4 N

4. (i) $F = R - mg$
$F = ma \rightarrow R - mg = m(0)$
$R = mg = 60 \times 10 = 600$ N
(ii) $F = R - mg$
$F = ma \rightarrow R - mg = m(-a)$
$R = mg - ma = 60(10) - 60(1) = 540$ N
(iii) $F = mg - R$
$F = ma \rightarrow mg - R = ma$
$R = mg - ma = 60(10) - 60(2) = 480$ N

5. (a) $F = mg - G$
$= 5(10) - 10$
$= 40$ N

(b) $F = ma$
$40 = (10+5)a$
$a = 40 \div 15 = 2.7$ m s^{-2}

(c) $F = ma$
$50 - T = 5(2.7)$
$T = 50 - 13.5$
$= 36.5$ N

(b) (a) $F = (10 - 5)g$
$= 10(10) - 5(10)$
$= 50$ N

(b) $F = ma$
$50 = (10+5)a$
$a = 50 \div 15 = 3.3$ m s^{-2}

(c) $F = ma$
$T - 50 = 5(3.3$ N$)$
$T = 50 + 16.5$
$= 66.5$ N

1.2 Leraian Daya
Resolution of Forces

1. leraian / *resolving*

Meleraikan daya yang bertindak pada sebuah objek pada suatu sudut condong
Resolving forces acting on an object at an inclined plane

1. (a) $F_x = F \cos\theta$
(b) $F_y = F \sin\theta$
(c) $F_x = mg \sin\theta$
(d) $F_y = mg \cos\theta$
(e) $R = F_y = mg \cos\theta$
(f) $G = F_x = mg \sin\theta$
(g) $mg \sin\theta - G$

2. (a) $F_x = F \cos\beta$
(b) $F_y = F \sin\beta$
(c) $F_x = mg \sin\theta$

(d) $F_y = mg \cos \theta$
(e) $R = F_y = mg \cos \theta$
(f) $mg \sin \theta + G = T$
(g) $T - (mg \sin \theta + G)$

Menyelesaikan masalah melibatkan daya paduan dan leraian daya
Solving problems involving resultant force and resolving forces

Contoh 1

$F_x = 8g \sin 30^\circ$
$= 8 \times 10 \times 0.5 = 40$ N

$F_{50N} = 50 \text{ kos } 30^\circ = 43.3$ N

$F = 43.3 \text{ N} - 40 \text{ N} = 3.3$ N

Contoh 2

(a) $W_c = mg \sin 45^\circ$
$= 70 \times 10 \times \sin 45^\circ$
$= 495$ N

(b) $W_b = mg \cos 45^\circ$
$= 70 \times 10 \times \text{kos } 45^\circ$
$= 495$ N

(c) $R = W_b = 364.4$ N

(d) $F = W_c$ – daya geseran
$= 495 \text{ N} - 120 \text{ N}$
$= 375$ N

Tugasan 2

1. (a) $OX = 100 \text{ N} \sin 30^\circ$
$= 50$ N

$OY = 100 \text{ N kos } 30^\circ$
$= 87$ N

(b) $OX = -200 \text{ N kos } 50^\circ$
$= -129$ N

$OY = 200 \text{ N} \sin 50^\circ$
$= 153$ N

(c) $OX = 400 \text{ N kos } 70^\circ$
$= 137$ N

$OY = -400 \text{ N} \sin 70^\circ$
$= -376$ N

2. (a) (i) $100 \text{ kos } 40^\circ - 20$
$= 56.6$ N

(ii) $100 \sin 40^\circ - 50$
$= 14.3$ N

(b) (i) $\theta = 30^\circ$
$F_x = 5 \times 10 \sin 30^\circ = 50 \times 0.5 = 25$ N
$F_y = 5 \times 10 \text{ kos } 30 = 43.3$ N
$R = F_y = 43.3$ N

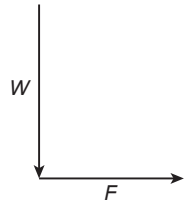
(ii) $F \text{ kos } 40^\circ - F_x - G$
$= 100 \text{ kos } 40^\circ - 25 - 20$
$= 76.6 - 45$
$= 31.6$ N

1.3 Keseimbangan Daya
Forces in Equilibrium

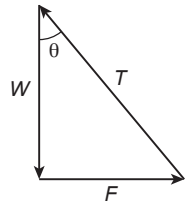
1. keseimbangan, sifar / *equilibrium, zero*
2. keseimbangan / *equilibrium*

Melakar segi tiga daya bagi tiga daya yang berada dalam keseimbangan
Drawing a triangle of forces for three forces are in equilibrium

2. paduan, sifar // *resultant, zero*
(a)



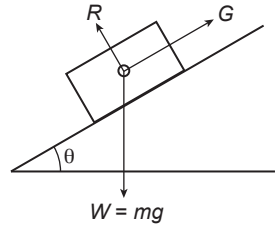
(b)



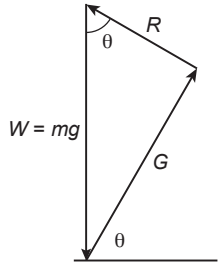
3. tertutup, sifar, keseimbangan / *closed, zero, equilibrium*
4. $W + F + T = 0$

Aktiviti 1.1

Kes I / *Case I*:
(a)

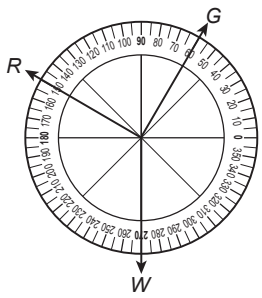


(b)



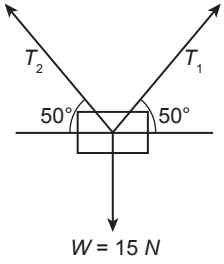
(c)

Daya / *Force*	Arah / *Direction*
W	270°
G	60°
R	150°

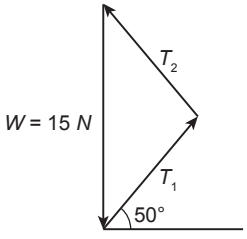


Kes II / *Case II* :

(a)

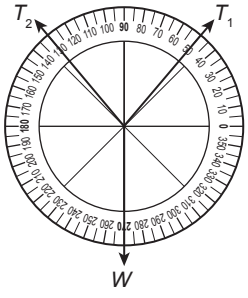


(b)



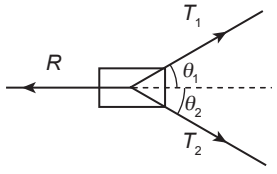
(c)

Daya / *Force*	Arah / *Direction*
W	270°
T_1	50°
T_2	130°

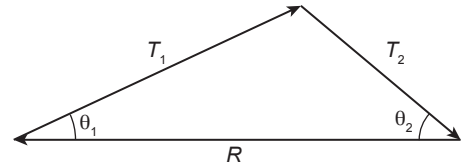


Kes III / *Case III* :

(a)

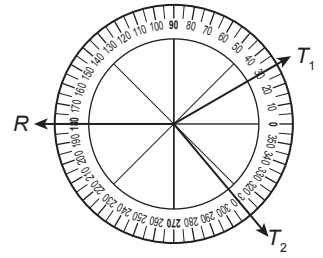


(b)



(c)

Daya / *Force*	Arah / *Direction*
R	180°
T_1	30°
T_2	310°



Menyelesaikan masalah melibatkan keseimbangan daya
Solving problems involving forces in equilibrium

Contoh 1

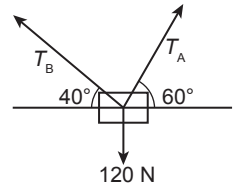
T_3 = 100 N

$T_1 = \frac{100}{\sin 60°} = 115.5$ N

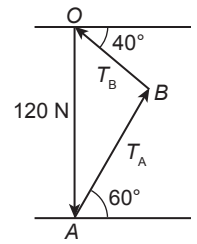
T_2 = 115.5 × kos 60°
= 57.7 N

Contoh 2

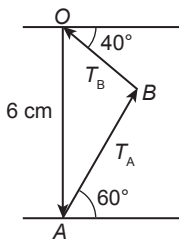
1.



2.



3.

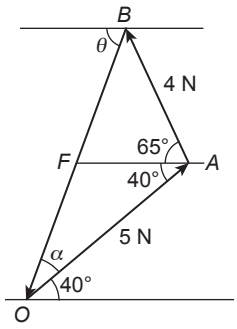


- Panjang / *length of* AB = 4.7 cm
  maka, *therefore*, T_A = 4.7 × 20 N
  = 94 N

  Panjang / *length of* BO = 3.0 cm
  maka, *therefore*, T_B = 3.0 × 20 N
  = 60 N

Contoh 3

1.



2. $F^2 = 4^2 + 5^2 - 2(4)(5) \cos 105°$
$= 16 + 25 - 40(-0.2588)$

$F = \sqrt{51.35}$
$= 7.17$ N

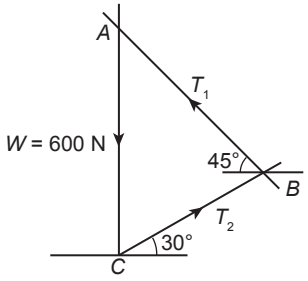
3. $\sin \alpha = \dfrac{4 \times \sin 105}{7.17} = 0.5389$

$\alpha = 32.6°$
$\therefore \theta = 32.6 + 40 = 72.6°$

Tugasan 3

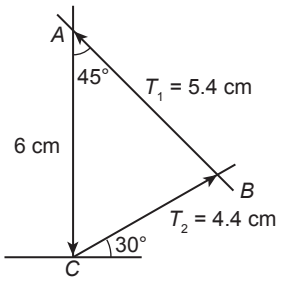
Situasi / *Situation* (I)

(a)



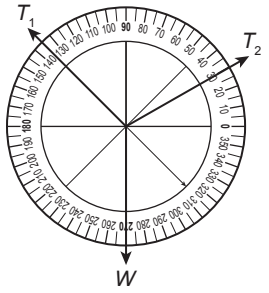
(b) (i) $T_1 \cos 45° = T_2 \cos 30°$
$T_1 \sin 45° + T_2 \sin 30° = 600$
$T_1 = 1.22\ T_2$ atau / *or* $T_2 = 0.82\ T_1$
$T_1 \times 0.707 + T_2 \times 0.5 = 600$
$0.707\ T_1 + 0.82\ T_1 \times 0.5 = 600$
$1.527\ T_1 = 1200$
$T_1 = 786$ N
$T_2 = 0.82 \times 786 = 644.5$ N

(ii)



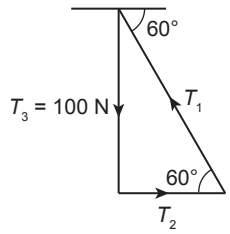
$T_1 = 5.4 \times 100$ N = 540 N
$T_2 = 4.4 \times 100$ N = 440 N

(c)



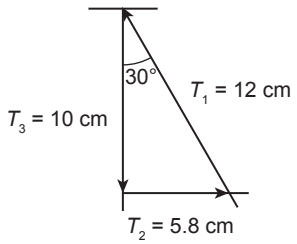
Situasi / *Situation* (II)

(a)



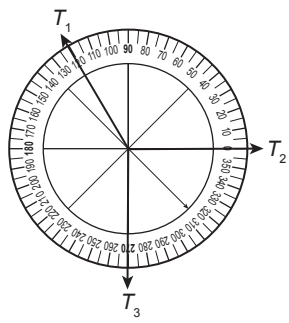
(b) (i) $T_1 \cos 60° = T_2$
$T_1 \sin 60° = 100$
$T_1 = 115.5$ N
$T_2 = 115.5 \times \cos 60° = 57.7$ N

(ii)



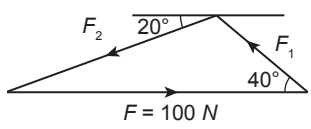
$T_1 = 12 \times 10$ N = 120 N
$T_2 = 5.8 \times 10$ N = 58 N

(c)



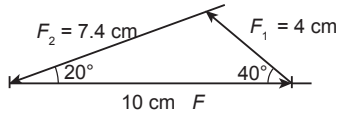
Situasi / *Situation* (III)

(a)



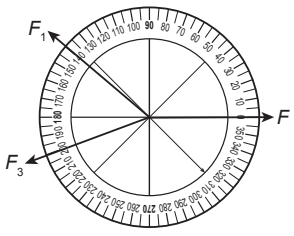
(b) (i) F_1 kos 40° + F_2 kos 20° = 100
F_1 sin 40° = F_2 sin 20°
F_1 = 0.53 F_2 atau / *or* F_2 = 1.88 F_1
F_1 × 0.766 + F_2 × 0.94 = 100
F_1 × 0.766 + 1.88 F_1 × 0.94 = 100
2.65 F_1 = 106.4
F_1 = 40.2 N
F_2 = 1.88 x 40.2 = 75.5 N

(ii)



F_1 = 4 × 10 N = 40 N
F_2 = 7.4 × 10 N = 74 N

(c)



1.4 Kekenyalan
Elasticity

1. kembali, daya / *return, force*

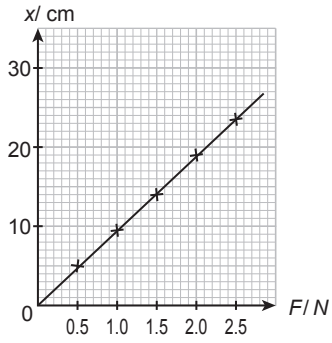
Eksperimen 1.2

Pemboleh ubah / *Variables*:
(a) Daya, *F* (berat pemberat yang ditambahkan) / *Force, F (slotted weight added)*
(b) Pemanjangan spring / *Extension of the spring, x*
(c) Panjang dan jenis spring / *Length and type of spring*

Keputusan / *Results*:

Berat beban *Weight of load* *F* / N	Panjang spring *Length of spring* *l* / cm	Pemanjangan *Extension* $x = (l - l_o)$ / (cm)
0.5	20.0	5.0
1.0	24.5	9.5
1.5	29.0	14.0
2.0	34.0	19.0
2.5	38.5	23.5

7.



Perbincangan / *Dicussion*:
garis lurus, asalan, positif, daya, berkadar terus, panjang pemanjangan
straight line, origin, positive, force, porportional, extension of length

Kesimpulan / *Conclusion*:

Daya berkadar terus dengan pemanjangan spring. Semakin besar daya, semakin besar pemanjangan spring.
The force is proportional to the extension of the spring. The larger the force, the longer the extension of the spring.

Hukum Hooke
Hooke's Law

1. pemanjangan, terus, daya, melebihi
extension, proportional, force

Menganalisis graf daya, *F* melawan pemanjangan spring, *x*
Analysis of graph of force, F against the extension of spring, x

(a) dipatuhi / *obeyed //* pemalar spring / *spring constant*
N m^{-1}
(b) tidak / *not*

2. kuat, besar / *stiffer, larger*

Tenaga keupayaan kenyal tersimpan dalam spring
Elastic potential energy stored in spring

1. tenaga keupayaan kenyal / *elastic energy*

2. $\frac{1}{2}kx$

3. $E = \frac{1}{2}Fx$

$= \left(\frac{1}{2}kx\right).\ x = \frac{1}{2}kx^2$

4. $= \frac{1}{2} Fx$

$= \frac{1}{2} (kx) \times x = \frac{1}{2} kx^2$

Faktor-faktor yang mempengaruhi pemalar spring, *k*
Factors affecting spring constant, k

1. (a) bahan, pemalar spring / *materials, spring constant*
(i) kuat / *stiffer*
(ii) keluli, kuprum / *steel, copper*
(b) pemalar spring / *spring constant*
(i) pendek, panjang / *Shorter, longer*
(ii) pendek, panjang / *shorter, longe*
(c) kecil, kuat, besar / *smaller, stiffer, larger*
(i) kecil, besar / *small, larger*
(d) besar, kecil / *larger, smaller*
(i) tebal, kecil / *thicker, thinner*

2. susunan, sesiri, selari
arrangement, series, parallel

3. kuat, besar / *stiffer, larger*

4. lembut, kecil / *softer, smaller*

5. $<, <$

Menyelesaikan masalah melibatkan daya dan pemanjangan spring
Solving problem involving force and spring extensio

Contoh 1

Daya / *Force* = Berat / *Weight*
$= mg = 0.05 \text{ kg} \times 10 \text{ N kg}^{-1} = 0.5 \text{ N}$

(a) $k = \frac{F}{x} = \frac{0.5 \text{ N}}{2 \text{ cm}} = 0.25 \text{ N cm}^{-1}$

(b) $x = 18 \text{ cm} - 12 \text{ cm} = 6 \text{ cm}$

$F = kx = 0.25 \text{ N cm}^{-1} \times 6 \text{ cm}$
$= 1.5 \text{ N}$

Contoh 2

(a) Daya / *Force*, $F = mg = \frac{100}{1000} \times 10 = 1.0 \text{ N}$

Pemampatan / *Compression*, $x = 20 \text{ cm} - 16 \text{ cm} = 4 \text{ cm}$

Pemalar spring / *Spring constant*, $k = \frac{F}{x} = \frac{1 \text{ N}}{0.04 \text{ m}} = 25 \text{ N m}^{-1}$

Tenaga keupayaan kenyal tersimpan dalam spring
Elastic potential energy stored in spring

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

$= \frac{1}{2} \times 25 \text{ N m}^{-1} \times 0.0016 \text{ m}^2$

$= 0.02 \text{ N m} / 0.02 \text{ J}$

(b) Daya / *Force*, $F = mg = 0.3 \text{ kg} \times 10 \text{ N kg}^{-1} = 3.0 \text{ N}$

Daya yang memampat satu spring / *Force that compress a single spring* $= \frac{1}{2} \times 3.0 \text{ N} = 1.5 \text{ N}$

Pemampatan / *Compression*,

$x = \frac{F}{k} = \frac{1.5 \text{ N}}{25 \text{ N m}^{-1}} = 0.06 \text{ m} = 6 \text{ cm}$

Oleh itu, / *Therefore*, $y = 20 \text{ cm} - 6 \text{ cm} = 14 \text{ cm}$

Contoh 3

(a) 10 N, 20 N

(b) Kecerunan graf untuk spring *P* / *Gradient of spring P*

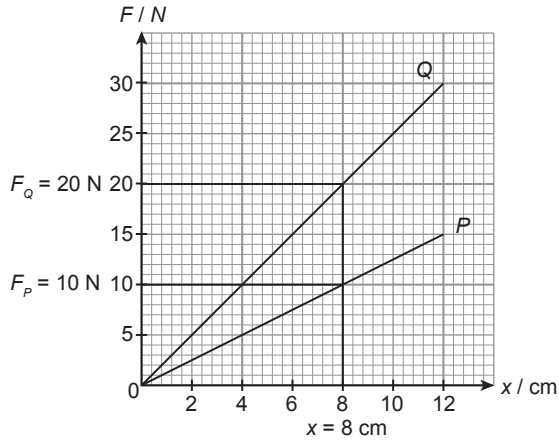
$= \frac{15 \text{ N}}{12 \text{ cm}} = 1.25 \text{ N cm}^{-1}$

Maka, pemalar spring *P* / *Therefore, spring constant P*
$= 1.25 \text{ N cm}^{-1}$

Kecerunan graf untuk spring *Q* / *Gradient of graph for spring Q*

$= \frac{30 \text{ N}}{12 \text{ cm}} = 2.5 \text{ N cm}^{-1}$

Maka, pemalar spring *Q* / *Therefore, spring constant Q*
$= 2.5 \text{ N cm}^{-1}$



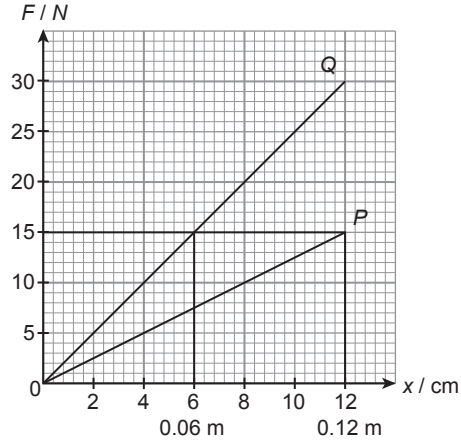
(c) Luas di bawah graf untuk spring *P* / *Area under the graph for spring P* $= \frac{1}{2} \times 15 \text{ N} \times 0.12 \text{ m} = 0.9 \text{ N m} = 0.9 \text{ J}$

Maka, tenaga keupayaan kenyal tersimpan dalam spring *P* ialah 0.9 J
Therefore, elastic potential energy stored in spring P is 0.9 J.

Luas di bawah graf untuk spring *Q* / *Area under the graph for spring Q*

$= \frac{1}{2} \times 15 \text{ N} \times 0.06 \text{ m} = 0.45 \text{ N m} = 0.45 \text{ J}$

Maka, tenaga keupayaan kenyal tersimpan dalam spring *Q* ialah 0.45 J.
Therefore, elastic potential energy stored in spring P is 0.45 J.



Tugasan 4

1. (a) Daya bertindak pada spring / *Force that acted on the spring,* $F = mg$

Daya / *Force,* $F = \frac{500}{1000} \times 10 = 5$ N

(b) Pemanjangan / *Extension,*
$x = 33$ cm $- 25$ cm $= 8$ cm $= 0.08$ m

(c) Pemalar spring / *Spring constant,*

$k = \frac{F}{x} = \frac{5}{0.08} = 62.5$ N m^{-1}

2. (a) Jumlah pemanjangan
Total extension
= 4 cm + 4 cm
= 8 cm

(b) Jumlah pemanjangan
Total extension
= (4 cm ÷ 2)
= 2 cm

(c) Jumlah pemanjangan
Total extension
= (4 cm ÷ 2) + 4 cm
= 6 cm

(d) Jumlah pemanjangan
Total extension
= (4 cm ÷ 2) + (4 cm ÷ 2)
= 4 cm

PRAKTIS SPM 1

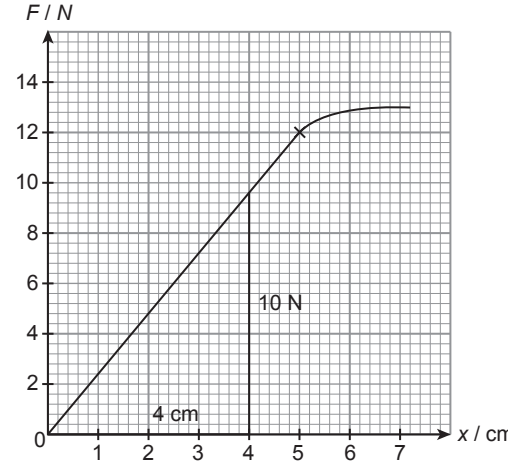
Soalan Objektif

1. B **2.** C **3.** A **4.** B **5.** B

Soalan Struktur

Bahagian A

1.



(a) (ii) Hukum Hooke / *Hooke's law*
(iii) Pemalar spring = kecerunan graf,
Spring constant = gradient of graph

$k = \frac{F}{x} = \frac{10 \text{ N}}{4 \text{ cm}}$
$= 2.5$ N cm^{-1}

(b) Tenaga tersimpan dalam spring $= \frac{1}{2} Fx$
Energy stored in spring
$= \frac{1}{2} \times 10 \text{ N} \times 0.04 \text{ m}$
$= 0.2 \text{ N m} = 0.2 \text{ J}$

2. (a) Berat pelajar / *Weight of student* = 600 N

(b) • Bergerak ke atas dengan halaju seragam.
Moving up with uniform velocity.
• Bergerak ke bawah dengan halaju seragam.
Moving down with uniform velocity.

(c) $F = mg - R$

(d) Apabila lif bergerak ke atas dengan pecutan, a, daya paduan F bertindak pada pelajar ialah $R - mg$.
When the lift moves upward with acceleration a, the resultant force F acting on the student is R - mg.
$F = mg - R = ma \rightarrow R = mg + ma$.
$\therefore R > mg$,
Tindak balas R lebih besar daripada berat mg.
The normal reaction R is greater than the weight mg

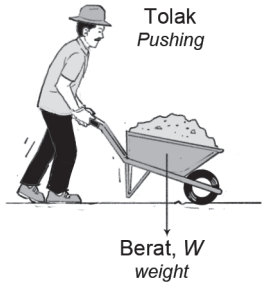
Bahagian C

3. (a) (i) $F = ma$
$T - 300 \text{ N} = (1000)(0)$
$T = 300$ N

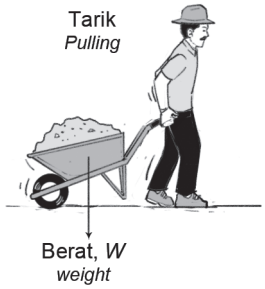
(ii) $F = ma$
$T - 300 \text{ N} = (1000)(1.5)$
$T = 1500 + 300$
$T = 1800$ N

(iii) $F = ma$
$3000 - 300 = 1000a$
$a = 2.7$ m s^{-2}

(b) (i)



(ii)



(iii) Kaedah yang lebih sesuai ialah menarik kereta sorong.
The more suitable way is to pull the wheelbarrow.

(c)

Cadangan *Suggestions*	**Penerangan** *Explanation*
Ketumpatan tiang yang rendah *Low density of pole*	Supaya tiang ringan dan senang diangkat. *So that the pole is light and easy to carry.*
Tiang harus mempunyai kelenturan yang tinggi. *The pole should have high flexibility.*	Supaya senang dibengkokkan apabila ditiup oleh angin yang kuat. *So that it can bend easily when blown by strong wind.*
Tiang haruslah kuat *The pole should be strong.*	Supaya tidak senang patah apabila dikenakan daya yang kuat. *So that the pole does not easily break when experiencing a strong force*
Tali harus mempunyai ketegangan maksimum yang tinggi. *The rope has high maximum tension.*	Supaya tali tidak mudah putus. *So that the rope does not break easily.*
Tiang diikat pada kedudukan yang tinggi. *The rope is tied at high position.*	Supaya tiang dapat didirikan lebih stabil di atas tanah. *So the pole can stand more stable on the ground.*

BAB 2

Tekanan
Pressure

2.1 Tekanan Cecair
Pressure Liquids

Rumus tekanan cecair
Liquid pressure formula

1. Isi padu cecair = luas tapak × kedalaman
Volume of liquid = base area × depth

$V = A \times h$

Berat cecair / *Weight of liquid* = mg
$= \rho \times A \times h \times g$

Daya disebabkan oleh berat cecair
Force due to weight of liquid

$F = \rho \times A \times h \times g$

Maka, tekanan cecair / *So, liquid pressure*

$$P = \frac{\text{daya}}{\text{luas}} = \frac{F}{A}$$
$$= \frac{\rho Ahg}{A}$$
$$= \rho hg$$

2. ρ = ketumpatan cecair / *density of liquid*,
h = kedalaman cecair / *depth of liquid*,
g = pecutan graviti / *gravitational acceleration*

3. tekanan, berkadar terus, kedalaman, ketumpatan, tidak bergantung, luas permukaan
pressure, proportional, depth, density, does not depend, base area

Contoh 1

Penyelesaian / *Solution:*

ρ = Ketumpatan air / *Density of water* = 1000 kg m^{-3}
h = Kedalaman air / *Depth of water* = 2 m
g = 10 N kg^{-1}

Tekanan air / *Pressure of water* = ρhg
= 1000 kg m^{-3} × 2 m × 10 N kg^{-1}
= 20 000 N m^{-2}
= 20 000 Pa

Eksperimen 2.1

(I) Mengkaji kesan kedalaman ke atas tekanan cecair
To study the effect of depth on liquid pressure

Pemboleh ubah / *Variable*:
(a) Kedalaman cecair / *Depth of liquid*
(b) Tekanan cecair / *Pressure of liquid*
(c) Ketumpatan cecair / *Density of liquid*

Pemerhatian dan perbincangan / *Observation and discussion:*

Tiub kaca *Glass tube*	**Kedalaman air** *Depth of water*	**Tekanan air** *Water pressure*	**Jarak air dipancut keluar** *Distance of waterjet throw*
P	h_1: paling kecil / *smallest*	Paling rendah / *lowest*	J_1: paling dekat / *nearest*
Q	h_2: kedua kecil / *smaller*	Kedua rendah / *lower*	J_2: kedua dekat / *nearer*
R	h_3: kedua besar / *deeper*	Kedua tinggi / *higher*	J_3: kedua jauh / *further*
S	h_4: paling besar / *deepest*	Paling tinggi / *highest*	J_4: paling jauh / *furthest*

1. semakin besar kedalaman, semakin besar tekanan
greater the depth, higher the water pressure

2. kedalaman, tekanan / *the depth, pressure*

(II) Mengkaji kesan ketumpatan terhadap tekanan air
To study the effect of density on liquid pressure

Pemboleh ubah / *Variable*:
(a) Ketumpatan cecair / *Density of liquid*
(b) Tekanan cecair / *Pressure of liquid*
(c) Kedalaman cecair / *Depth of liquid*

Perbincangan / *Dicussion*:

1. lebih tumpat, tekanan yang lebih tinggi, kurang tumpat, tekanan yang lebih rendah
higher density, greater pressure, density, less pressure

2. tekanan cecair bertambah, ketumpatan cecair
liquid pressure increases, density of liquid

(III) Menunjukkan bahawa luas keratan rentas dan bentuk bekas tidak mempengaruhi tekanan cecair
To show that the cross-sectional area and the shape of the container do not affect liquid pressure

1. sama, kedalaman, tekanan, sama
   same, depth, pressure, same
2. =, =, =
3. (a) sudut kecondongan / *angle of inclination*
   (b) luas / *area*
   (c) bentuk / *shape*

Kesimpulan / *Conclusion*:

1. dalam, tinggi / *greater the depth, higher the pressure*
2. tumpat, tinggi / *denser, higher*
3. luas keratan rentas, bentuk bekas, kedalaman cecair
   cross-sectional area, shape, depth of the liquid

Menentukan ketumpatan suatu cecair yang tidak diketahui dengan menggunakan tiub-U
To determine the density of an unknown liquid using a U-tube

2. (a) Berat, berat / *weight, weight*
   (b) Tekanan, Tekanan / *pressure, pressure*
   (c) $h_1\rho_1 g = h_2\rho_1 g$ atau / *or* $h_1\rho_1 = h_2\rho_2$
3. $h_1\rho_1 = h_2\rho_2$
   $8\text{ cm} \times 1000\text{ kg m}^{-3} = 10\text{ cm} \times \rho_2$
   $\rho_2 = 800\text{ kg m}^{-3}$

Contoh 1

Tekanan air / *Water pressure* = $h\rho g$
$= 25 \times 1000 \times 10$
$= 250\,000$ Pa

Contoh 2

Tekanan air laut / *seawater pressure* = $h\rho g$
$1.7 \times 10^8 = h \times 1.02 \times 10^3 \times 10$
$h = \dfrac{1.7 \times 10^8}{1.02 \times 10^3 \times 10}$
$= 1.67 \times 10^4$ m

Kedalaman laut / *Depth of ocean* = 1.67×10^4 m

Contoh 3

Tekanan air laut / *seawater pressure* = Tekanan air / *Water pressure*
$h_1\rho_1 = h_2\rho_2$
$h \times 1050 = 5 \times 1000$
$h = 4.76$ m

Oleh itu, kedalaman air laut / *Therefore, the depth of seawater* = 4.76 m.

Aplikasi tekanan cecair dalam kehidupan
Application of pressure in liquid in our lives

(I) paling tinggi, tekanan air yang tinggi, tinggi, tinggi, ketinggian, lebih tinggi
highest, high water pressure, higher, higher, height, above

(II) • lebih tinggi / *higher*
• tekanan yang cukup tinggi / *sufficient pressure*

(III) (a) lebih tebal / *much thicker*
(b) Tekanan, kedalaman, tekanan, lebih tinggi
pressure, depth, greater, pressure
(c) lebih luas, lebih tebal, kuat dan stabil, menyokong, penambahan tekanan air
broader, thicker, strong and stable, support, increased water pressure
(d) tebal, tekanan / *thick, pressure*
(e) tinggi, tinggi / *higher, higher*
(f) tenaga kinetik, tenaga keupayaan
kinetic energy, potential energy

(IV) (a) memindahkan, lebih tinggi, lebih rendah
transfer, higher, lower level
(b) lebih rendah / *lower*
(c) tarikan graviti, vakum separa, tekanan yang lebih tinggi
pull of gravitiy, partial vacuum, higher pressure
(d) mengeluarkan petrol, air kotor
remove petrol, dirty water

***Tugasan* 1**

1. (a) Tekanan / *Pressure* = $h\rho g$
   $= 1.5\text{ m} \times 1000\text{ kg m}^{-3} \times 10\text{ N kg}^{-1}$
   $= 15\,000\text{ N m}^{-2}$ / Pa
   (b) Tekanan / *Pressure* = $h\rho g$
   $= 0.5\text{ m} \times 1000\text{ kg m}^{-3} \times 10\text{ N kg}^{-1}$
   $= 5\,000\text{ N m}^{-2}$ / Pa
2. $h_C\,\rho_X = h_Y\,\rho_Y$
   $(h + 12) \times 800 = 12 \times 1050$
   $h + 12 = 15.75$
   $h = 3.75$ cm

2.2 Tekanan Atmosfera
Atmospheric Pressure

1. atmosfera, daya tarikan graviti, berat, tekanan atmosfera
   atmosphere, gravitational force, weight

Menentukan nilai tekanan atmosfera
To determine the value of atmospheric pressure

1. barometer / *barometer*
2. 1 meter, merkuri / *1 meter, mercury*
   (a) Ini kerana tekanan atmosfera yang bertindak pada permukaan merkuri di dalam takungan itu hanya cukup besar untuk menyokong berat turus merkuri sebanyak 76 cm sahaja.
   This is because the atmospheric pressure acting on the surface of the mercury in the reservoir is only large enough to support the weight of the mercury column of 76 cm only.
   (b) (i) 76 cmHg
   (ii) Tekanan atmosfera / *Atmospheric pressure* = $h\rho g$
   $= 0.76 \times 1.36 \times 10^4 \times 10$
   $= 1.0 \times 10^5$ Pa
   (c) Tekanan sifar / *Zero pressure*

3.

Barometer merkuri ***Mercury barometer (Fortin barometer)***	**Barometer aneroid** ***Aneroid barometer***
• Dengan menyesuaikan ketinggian merkuri di dalam tiub untuk mengukur tekanan atmosfera. *By adjusting the height of mercury inside the tube to measure atmospheric pressure.*	• Menggunakan sebuah kotak logam kecil yang fleksibel untuk mengukur tekanan atmosfera. *It uses a small flexible metal box to measure the atmospheric pressure.*
• Mengukur tekanan luaran dengan mengukur kenaikan atau ketinggian turus merkuri di dalam tiub kaca tegak. *It measures the external pressure by measuring the rise or the height of mercury inside the vertical glass tube.*	• Mengukur tekanan luaran menggunakan pengembangan atau penguncupan kotak logam fleksibel yang menyebabkan gerakan petunjuk pada skala tekanan untuk mendapat bacaan. *It measures the external pressure using the expansion or contraction of a flexible metal box which leads to moving a needle on a pressure scale to get the reading.*
• Barometer merkuri adalah besar dan berat, sukar untuk dikendalikan dan diangkut. *The mercury barometer is large and heavy, it is hard to handle and transport.*	• Mudah dikendalikan dan diangkut. *It is easy tohandle and transport.*
• Adalah sukar untuk mengambil ukuran daripada barometer merkuri kerana ketinggian harus diukur dengan tepat selepas diimbangkan. *It is hard to take a measurement from the mercury barometer since the height should be measured accurately after it gets balanced.*	• Memberi bacaan secara langsung dan oleh itu mudah untuk mengambil ukuran. *It directly gives a value and so it is easy to take a measurement.*

Menyelesaikan masalah dalam kehidupan harian yang melibatkan pelbagai unit tekanan
Solving problems in daily life involving various pressure units

1. pascal (Pa) / *pascal (Pa)*

2. mm Hg, m H_2O dan milibar (mbar)
mm Hg, m H_2O and millibar (mbar)

Contoh 1

(i) Tekanan atmosfera / *Atmospheric pressure*
= 74 cm Hg
= 740 mm Hg

(ii) Tekanan atmosfera / *Atmospheric pressure*
= $h\rho g$
= 0.74 m × 13.6 × 10^3 kg m^{-3} × 9.8 N kg^{-1}
= 98 627 N m^{-2} = 9.86 × 10^3 Pa

Contoh 2

(i) Tekanan air / *Water pressure*
= Tekanan air laut / *seawater pressure*

$$h_1\rho_1 g = h_2\rho_2 g$$
$$h_1 \times 1000 = 20 \times 1050$$
$$h_1 = 21 \text{ m } H_2O$$

(ii) Tekanan sebenar / *Actual pressure*
= (10 + 21) m H_2O
= 31 m H_2O

Kesan tekanan atmosfera ke atas objek pada altitud tinggi
Effect of atmospheric pressure on object at high altitude

1. Altitud, tekanan atmosfera, nipis, rendah
altitude, atmospheric pressure, thinner, lower

2. rendah, lebih rendah, tinggi
lower, lower, high

3. rintangan, rendah, tinggi
lower, air resistance, high

4. terlalu tinggi, tidak, nipis, mengangkat, tidak dapat
too high, insufficient, lift, unable

5. pakaian angkasa, oksigen, tekanan
spacesuits, oxygen, pressure

6. tekanan, lebih larut, lebih besar, larut
pressure, more soluble, greater, disolved

7. air, tekanan, Semakin dalam, tekanan, tekanan air, tekanan udara
weight, pressure, deeper, pressure, water pressure, air pressure

8. tekanan atmosfera, tekanan air + 1 tekanan atmosfera
atmospheric pressure, water pressure + 1 atmospheric pressure

9. sangat tinggi, lebih besar, Semakin dalam
deeper, greater

Tugasan 2

1. Aneroid barometer

2. Ini kerana tekanan atmosfera berubah dengan ketebalan atmosfera. Semakin tinggi kapal terbang naik ke udara, semakin rendah tekanan atmosfera.
This is because atmospheric pressure changes with thickness of air. The higher the airplane rises, the lower the atmospheric pressure.

3. (a) (i) 750 mm Hg
(ii) Tekanan / *Pressure* = $h\rho g$
= 0.75 m × (13.6 × 10^3 kg m^{-3}) × 10 N kg^{-1}
= 102 000 Pa = 1.02 × 10^5 Pa

(b) (i) 75 cm
(ii) 0 Pa

(c) Turus merkuri akan turun ke bawah sehingga parasnya sama dengan paras merkuri dalam takungan. Ini kerana tekanan dalam tiub sama dengan tekanan atmosfera.
The mercury column will fall until the level of mercury in the reservoir. This is because the pressure inside the tube is equal to the atmospheric pressure.

2.3 Tekanan Gas
Gas Pressure

1. Manometer, tekanan gas / *manometer, gas pressure*
2. tiub-U, tertutup, tekanan gas / *U-tube, closed, gas pressure*
3. air, merkuri, tekanan gas, $h\rho g$
   water, mercury, gas pressure, $h\rho g$
4. hujung terbuka, perbezaan
   open-end manometer, difference
5. sama / *equal*
6. lebih besar / *greater*
7. lebih besar / *greater*

Menyelesaikan masalah dalam kehidupan harian yang melibatkan tekanan gas
Solving daily life problems involving gas pressure

Contoh 1

Manometer hujung tertutup *Closed end manometer*	Manometer hujung terbuka *Open end manometer*	
P_{gas} $= h\rho g$ $= (5 \times 10^{-2}) \times 1000 \times 10$ $= 500$ Pa	P_{gas} $= P_{atm} + h\rho g$ $= 10^5 + (0.2 \times 1000 \times 10)$ $= 102\,000$ Pa	P_{gas} $= P_{atm} - h\rho g$ $= 10^5 - (0.3 \times 1000 \times 10)$ $= 97\,000$ Pa

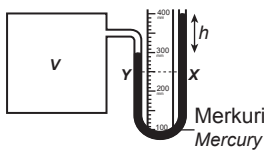
Contoh 2

(i) 0 mm Hg
(ii) = 920 mm Hg – 320 mm Hg
= 600 mm Hg
(iii) 920 mm Hg

Contoh 3

(a) Tekanan gas dalam *V* / *Gas pressure in V*
= Tekanan dari turus merkuri, *h* + tekanan atmosfera
Pressure due to mercury column, h + atmospheric pressure
= (400 – 300) + 760 = 860 mm Hg

(b)



Dua titik ialah *X* dan *Y*.
The two points are X and Y.

Tugasan 3

1. (a) Tekanan gas / *Gas pressure* = 6.8 cm Hg + 76 cm Hg
= 82.8 cm Hg
= 828 mm Hg

(b) 1 atm = 760 mm Hg,
$\therefore$ 828 mm Hg = 828 ÷ 760 = 1.09 atm

(c) 1 atm = 100 kPa
$\therefore$ 1.09 atm = 1.09 × 100 kPa = 109 kPa

2.4 Prinsip Pascal
Pascal's Principle

Sistem hidraulik sebagai satu sistem pengganda daya
Hydraulic system as a force multiplier system

1. omboh, omboh, tekanan / *piston, piston, pressure*
2. tekanan, dipindahkan, semua arah
   pressure, transmitted, all directions
4. $P_1 = P_2$
   $\frac{F_1}{A_1} = \frac{F_2}{A_2}$
   $F_2 = \frac{F_1}{A_1} \times A_2$ atau / *or* $F_2 = \frac{A_2}{A_1} \times F_1$
5. beban berat, daya kecil / *heavy load, small force*
6. $W_{input} = W_{output}$
   $F_1 \times d_1 = F_2 \times d_2$
   $d_2 = \frac{F_1}{F_2} \times d_1$
   atau / *or* $d_2 = \frac{A_1}{A_2} \times d_1$

Aplikasi prinsip Pascal
Applications of Pascal's principle

Brek hidraulik
Hydraulic brake

1. Prinsip Pascal, tekanan, sama / *Pascal's principle, equal pressure*
2. daya, silinder utama, tekanan bendalir, sama rata, semua omboh
   force, master cylinder, fluid pressure, equally, all the pistons
3. cakera brek, gelendung brek / *brakes disc, brake drum*
4. silinder, Tekanan, omboh kecil, kasut brek, geseran, menghentikan
   cylinders, pressure, small piston, brake shoe, frictional, stops
5. luar, kasut brek yang melengkung / *outward, curved brake shoe*

Jek hidraulik
Hydraulic jack

1. mengangkat beban berat, omboh kecil, injap *A,* tertutup
   lift heavy loads, small piston, valve A, closed
2. ke bawah, menolak, besar, injap *A,* injap *B*
   downward, push, large, valve A, valve B
3. luas yang besar, daya yang besar, beban yang berat
   large area, large force, heavy load
4. injap pelepas, omboh besar, turun
   release valve, large piston, descend

Menyelesaikan masalah dalam kehidupan harian yang melibatkan prinsip Pascal
To solve daily life problems involving Pascal's principle

Contoh 1

(a) Tekanan pada kedua-dua omboh / *Pressure at both pistons:*

$P_1 = \frac{F_1}{A_1}$ $P_2 = \frac{F_2}{A_2}$

Gunakan prinsip Pascal / *Using Pascal's principle:*

$P_1 = P_2$

$\frac{F_1}{A_1} = \frac{F_2}{A_s}$

$$\frac{F_1}{\pi \times \left(\frac{5}{100}\right)^2} = \frac{10000\ N}{\pi \times \left(\frac{20}{100}\right)^2}$$

$$F_1 = \frac{10000\ N}{\pi \times \left(\frac{20}{100}\right)^2} \times \pi \times \left(\frac{5}{100}\right)^2$$

$$= 625\ \text{N}$$

(b) $A_1 \times h_1 = A_2 \times h_2$

$$\pi \times \left(\frac{5}{100}\right)^2 \times h_1 = \pi \times \left(\frac{20}{100}\right)^2 \times 0.10$$

$$h_1 = 1.6\ \text{m}$$

Tugasan 4

1. F_1 = 10 N, A_1 = 10 cm^2, $F_2 = X$, A_2 = 100 cm^2

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{10\ N}{10\ \text{cm}^2} = \frac{X}{100\ \text{cm}^2}$$

$$X = 100\ \text{N}$$

2. (a) Tekanan / *Pressure* = 100 N ÷ 15 cm^2
= 6.7 N cm^{-2}

(b) Daya ke atas omboh *B* / *Force on piston B*
= Tekanan × Luas / *Pressure* × *Area*
= 6.7 N cm^{-2} × 2 cm^2
= 13.4 N

2.5 Prinsip Archimedes
Archimedes' Principle

1. tekanan cecair, kedalaman / *liquid pressure, depth*
(a) sama, seimbang / *equal, balanced*
(b) $h_2\rho g$, lebih besar, $h_1\rho g$ / $h_2\rho g$, *greater,* $h_2\rho g$
(c) P_2A, P_1A / P_2A, P_1A
$= F_2 - F_1$
$= P_2A - P_1A$
$= h_2\rho gA - h_1\rho gA$
$= (h_2 - h_1)\ A\rho g$
$= hA\rho g$
$= V\rho g$
(d) daya tujah, daya apungan / *upthrust force, buoyant force*
$F_A = V\rho g$
V = isi padu cecair yang disesarkan / *volume of liquid displaced*
ρ = ketumpatan cecair / *density of liquid*
g = daya graviti / *force of gravity*

3. tujah ke atas, sama, berat, disesarkan, Prinsip Archimedes
upthrust, equal, weight, displaced, Archimedes' principle

4. seluruh, sebahagian, direndamkan, daya apungan, sama, berat, disesarkan
partially, fully immersed, is equal, weight, liquid displaced
$F_A = \rho Vg$

Eksperimen 2.2

Pemboleh ubah / *Variable:*

(a) Berat air yang disesarkan / *Weight of water displaced*
(b) Daya apungan / *Buoyant force*
(c) Ketumpatan air / *Density of water*

Keputusan / *Results:*

Berat plastisin di dalam air *Weight of plasticine in water* W_2 / N	Daya apungan *Buoyant force* $W_1 - W_2$ / N	Berat air disesarkan *Weight of water displaced* W_d / N
0.25	0.25	0.26
0.48	0.52	0.53
0.70	0.80	0.79
0.95	1.05	1.05

Perbincangan / *Discussion:*

$$(W_1 - W_2) = W_d$$

Iaitu, berat air yang disesarkan sama dengan daya apungan
That is, the weight of the water displaced equals to the buoyant force

Daya apungan juga dikenali sebagai kehilangan berat ketara.
Buoyant force is also known as apparent lost in weight.

Keadaan keapungan suatu objek di dalam bendalir
The buoyancy of an object in a fluid

(a) daya apungan / *buoyant force* // terapung / *floats*
(b) daya apungan / *buoyant force*
tenggelam, ke bawah, pecutan / *sinks, downward, acceleration*
(c) daya apungan / *buoyant force*
terapung, ke atas, pecutan, di permukaan / floats, *upwards, acceleration, surface*

Aplikasi prinsip Archimedes dalam kehidupan
Application of Archimedes' principle in daily life

1. hidrometer, ketumpatan, Archimedes
hydrometer, density, Archimedes's

2. skala ketumpatan, daya tujah, terapung, tegak
density scale, upthrust, float, upright

3. rendah, ke dalam, tinggi, lebih tinggi, skala ketumpatan, bahagian atas
low, further down, higher, higher up, density scale, top

4. **Aktivitiy I / *Activity I***
Ketumpatan I / *Density brewer I* = 0.96 g cm^{-3}
Ketumpatan II / *Density brewer II* = 1.07 g cm^{-3}
Ketumpatan brewer II lebih tinggi daripada ketumpatan brewer I
The density of brewer II is higher than the density of brewer I
Ini menunjukkan bahawa brewer I sudah ditapai sepenuhnya menjadi alkohol, manakala kandungan gula dalam brewer II masih tinggi.
This shows that brewer I is fully fermented and becomes alcohol, whereas the sugar content in brewer II is still high.

Aktivitiy II / *Activity II*
Ketumpatan asid I / *Density of acid I* = 1.16 g cm^{-3}
Ketumpatan asid II / *Density of acid II* = 1.24 g cm^{-3}
Ketumpatan asid II lebih tinggi daripada ketumpatan asid I.
The density of acid II is higher than the density of acid I.
Ini menunjukkan bahawa ketumpatan asid I adalah kurang daripada 1.18 g cm^{-3}. Oleh itu, bateri perlu dicas semula.

Manakala, ketumpatan asid II adalah lebih besar daripada 1.18 g cm^{-3} dan hampir 1.3 g cm^{-3}. Oleh itu, bateri adalah dicas sepenuhnya.
This indicates that the density of acid I is less than 1.18 g cm^{-3}. Therefore, the battery should be recharged. While the density of acid II is greater than 1.18 g cm^{-3} and close to 1.3 g cm^{-3}, therefore the battery is fully charged.

Aktiviti 2.5

Perbincangan / *Discussion:*

1. tenggelam, tekanan memaksa air, memampatkan udara
   sink, pressure force the water, compressing the air
2. jisim, ketumpatan, tenggelam
   mass, density, sink
3. mengurangkan tekanan, air itu dipaksa keluar
   decreases the pressure, water is forced back out

Prinsip kerja tangki balast dalam kapal selam
The working principle of ballast tank in submarine

1. daya apungan / *buoyant force*
2. tangki balast, daya apungan, daya graviti
   ballast tank, buoyant force, buoyant force, gravity
3. tangki balast, ketumpatan, berat, daya apungan
   ballast tank, density, weight, buoyant force
4. air, keluar, termampat, ketumpatan, berat, lebih besar
   water, out, compressed, density, weight, larger

Kapal laut dan garis Plimsoll
Ship and Plimsoll lines

1. keluli, terapung, ketumpatan, kurang, isi padu udara, ketumpatan, lebih rendah, terapung
   steel, float, density, less, volume, air, lower density, floats
2. air, sama, daya apungan, berat, terapung
   water, equal, buoyant force, weight
3. terlebih muatan , ketumpatan, lebih besar, garis Plimsoll
   overloading, density, greater, Plimsoll line
4. • **TF** – Air Tawar Tropikal / *Tropical Fresh Water*
   • **F** – Air Tawar / *Fresh Water*
   • **T** – Air Laut Tropikal / *Tropical Seawater*
   • **S** – Musim Panas Sederhana Air Laut / *Summer Temperature Seawater*
   • **W** – Musim Sejuk Sederhana Air Laut / *Winter Temperature Seawater*
   • **WNA** – Musim Sejuk Atlantik Utara / *Winter North Atlantic*
5. Tanda Plimsoll / *Plimsoll mark*

Belon udara panas
Hot air Balloon

1. berketumpatan lebih rendah, berkurang, daya apungan
   lower density, decrease, buoyant force
2. sama, pegun, bergerak, halaju
   equal, stationary, velocity
3. lebih besar, naik, pecutan, daya pecutan
   greater, accelerated, an upwards

Menyelesaikan masalah yang melibatkan prinsip Archimedes dan keapungan
Solving problems involving Archimedes' principle and bouyant

Contoh 1

Daya apungan = Berat sebenar – Berat ketara
Buoyant force = Actual weight – Apparent weight
= 150 N – 102 N = 48 N

Dari prinsip Archimedes / *From Archimedes' principle*
Daya apungan = Berat air laut disesarkan
Buoyant force = Weight of seawater displaced

Maka / *Therefore,* $F = \rho Vg$
$48 = \rho \times (4800 \times 10^{-6}) \times 9.8$
$\rho = 1020$ kg m^{-3}

Ketumpatan air laut / *Density of the seawater* = 1020 kg m^{-3}

Contoh 2

(a) Untuk kapal boleh terapung, berat kapal mesti sama dengan daya apungan. Memandangkan ia adalah kapal yang sama, daya apungan yang bertindak terhadap kapal disebabkan air tawar dan air laut adalah sama.
For the boat to float, the weight of the boat must be equal to the buoyant force acting on it. Since it is the same boat, the buoyant force acting on the boat due to fresh water and the seawater are the same.

(b) Memandangkan daya apungan adalah sama dengan berat cecair yang disesarkan, berat air tawar yang disesarkan adalah sama dengan berat air laut yang disesarkan.
Since buoyant force is equal to the weight of liquid displaced, therefore the weight of fresh water displaced is the same as the weight of seawater displaced.

(c) Berat air tawar yang disesarkan= Berat air laut yang disesarkan,
Weight of fresh water displaced = Weight of seawater displaced,

$$\rho_{air/water} V_{air/water} g = \rho_{laut/sea} V_{laut/sea} g$$
$$\rho_{air/water} V_{air/water} = \rho_{laut/sea} V_{laut/sea}$$

Memandangkan isi padu air tawar yang disesarkan, $V_{water} >$ isi padu air laut yang disesarkan, V_{sea}.
Maka, ketumpatan air laut, ρ_{laut} > ketumpatan air tawar, ρ_{air}
Since the volume of fresh water displaced, $V_{water} >$ volume of seawater displaced, V_{sea}.
Therefore, the density of seawater, $\rho_{sea} >$ density of fresh water, ρ_{water}

Tugasan 5

1. (a) Daya apungan / *Buoyant force* = 30 – 24 = 6 N
   (b) Berat air disesarkan / *weight of water displaced*
   = Daya apungan / *Buoyant force*
   = 6 N
   (c) Berat air disesarkan / *Weight of water displaced* = ρVg
   6 N = 1000 kg $m^{-3} \times V \times 10$ N kg^{-1}
   $V = 6.0 \times 10^{-4}$ m^3
   (d) Isi padu bongkah = Isi padu air disesarkan
   Volume of block = Volume of water displaced
   $V = 6.0 \times 10^{-4}$ m^3
2. (a) Daya apungan / *Buoyant force*
   = Berat kapal / *Weight of the boat*
   = Berat air laut yang disesarkan / *Weight of seawater displaced*
   = ρVg
   = 1050 kg $m^{-3} \times (2.5 \times 10^3$ $m^3) \times 10$ N kg^{-1}
   = 2.625×10^7 N

(b) Berat kapal dengan muatan maksimum / *Weight of boat with maximum load*
$= 1050 \times 4.5 \times 10^3 \times 10$
$= 4.725 \times 10^7$ N
Berat barang tambahan / *Additional weight of good added*
$= 4.725 \times 10^7$ N $- 2.625 \times 10^7$ N
$= 2.1 \times 10^7$ N

2.6 Prinsip Bernoulli
Bernoulli's Principle

Kesan halaju bendalir kepada tekanan
Effect of speed of fluid flow on pressure

	Penjelasan / *Explanation*
1.	Apabila udara ditiup di bahagian atas sehelai kertas, udara mengalir pada kelajuan tinggi dan ini mewujudkan suatu kawasan bertekanan rendah di bahagian atas kertas. Udara pegun di bawah kertas berada pada tekanan yang lebih tinggi dan daya bersih ke atas menaikkan kertas. *As air is blown across the top of the paper, air flows at high speed and this creates a region of low pressure across the top of the paper. The still air beneath the paper is at a higher pressure and a net upwards force lifts the paper.*
2.	Apabila udara ditiup dengan kuat di antara dua belon, udara mengalir pada kelajuan tinggi dan ini mewujudkan suatu kawasan bertekanan rendah di antara dua belon itu. Udara di luar kawasan yang ditiup berada pada tekanan yang lebih tinggi dan menolak kedua-dua belon itu rapat bersama. *As air is blown vigorously between two balloons, air flows at high speed and this creates a region of low pressure between the two balloons. The air outside the blown area is at a higher pressure and forces the two balloons close together.*
3.	$P_A > P_C > P_B$ $V_A < V_C < V_B$ Tekanan dalam air berubah apabila air mengalir. Air mengalir dari kawasan bertekanan tinggi ke kawasan bertekanan rendah. Tekanan air berubah mengikut halaju aliran air seperti yang ditunjukkan dalam rajah. Tekanan air paling tinggi di bahagian halaju air mengalir terendah, manakala tekanan air paling rendah di bahagian halaju air mengalir tertinggi. *The pressure in the water changes as the water flows. Water flows from high pressure pressure areas to low pressure areas. Water pressure changes with the speed of water flow as shown in the figure. The water pressure is highest at the region where the speed of water flow is the lowest, while the water pressure is lowest at the region where the speed of water flow is the highest.*

kelajuan, meningkat, menurun / *speed, increase*

Daya angkat
Lift force

(I) **2.** naik, berkelajuan tinggi, bertekanan rendah, Tekanan atmosfera,lebih tinggi
rised,high speed, low pressure, higher atmospheric pressure

(II) **1.** Aerofoil, sayap, kelajuan tinggi, daya angkat
Aerofoil, wing, high-speed, lift

2. Prinsip Bernoulli,lebih jauh,lebih laju, lebih pendek, laju yang lebih rendah
Bernoulli's Principle, further, faster, shorter, lower speed

3. lebih laju, tekanan yang lebih rendah, lebih rendah, tekanan, lebih tinggi
faster, lower pressure, slower, higher pressure

4. tekanan, daya bersih / *pressure, net force*

5. $F = (P_2 - P_1) A$
$P_2 - P_1$ = Perbezaan tekanan / *Pressure difference*
A = Luas permukaan / *Surface area*

Aplikasi prinsip Bernoulli dalam kehidupan
Applying Bernoulli principles in daily life

Penunu Bunsen / *Bunsen burner*

1. halaju tinggi, tekanan, rendah
high velocity, pressure, low

2. lebih tinggi, gas, dan udara
higher, gas, air

Kereta lumba / *Racing car*

1. *spoiler,* cengkaman, halaju tinggi, kestabilan
spoilers, grip, high speed, stability

2. sayap pesawat, daya bersih ke bawah, kestabilan
airplane wing, downward net force, stability

Sukan / *Sports*

1. menyeret, putarannya, tekanan rendah dan tinggi, rendah
drag, its spin, low and high pressure, low

2. ke arah bawah, naik ke atas / *dip, rise*

Bidang aeronautik / *Aeronautical field*

1. penerbangan / *aviation*

2. kapal terbang kertas / *paper plane*

3. Peluncur, tanpa enjin / *glider, no engine*

4. aerodinamik, prinsip Bernoulli
aerodynamics, Bernoulli's principles

Tugasan 6

1. (a) Laju air pada P adalah lebih besar / *speed of water at P is larger.*

(b) Tekanan udara pada S adalah lebih besar / *Air pressure at S is larger.*

(c) Prinsip Bernoulli / *Bernoulli's principle*

PRAKTIS SPM 2

Soalan Objektif

1. B **2.** B **3.** C **4.** A **5.** C

Soalan Struktur

Bahagian A

1. (a) (i) Prinsip Pascal / *Pascal's principle*.
(ii) sama dengan / *same as*

(b) $\frac{F_1}{A_1} = \frac{F_2}{A_2} \rightarrow \frac{40}{1} = \frac{F_2}{25}$
$\therefore F_2 = 40 \times 25 = 1000$ N

(d) Mengubah nisbah luas keratan rentas omboh kecil dan omboh besar ke suatu nilai lebih besar daripada 1 : 25, misalnya 1 : 30.
To change the ratio of cross section of small and large piston to a value greater than 1 : 25, such as 1 : 30.

(e) Buka injap pelepas / *Open the released valve.*

Bahagian B

2. (a) Prinsip Pascal / Pascal's principle

(b) Apabila pedal brek ditekan, daya pada omboh silinder induk mengenakan tekanan pada bendalir brek. Tekan ini dihantar secara seragam ke setiap silinder pada roda, menyebabkan omboh di roda untuk menolak kasut break untuk menekan permukaan brek. Geseran antara brek dan kasut brek menyebabkan kenderaan perlahan dan berhenti.
When the brek pedal is pressed, the force on the piston of master cylinder applies a pressure on the brek fluid. This pressure is transmitted uniformly to each cylinder at the wheel, cause the piston at the wheels to push the brake shoes to press against the surface of the brake. The friction between the brakes and brake shoes causes the vechile to slow down and stop.

(c)

Aspek-aspek *Aspects*	**Keterangan** *Explanation*
Diameter omboh silinder induk adalah kecil. *Diameter of piston master cylinder is small.*	Apabila suatu daya kecil dikenakan padanya, suatu tekanan yang besar dihasilkan untuk memampatkan bendalir brek. *When a small force is applied to it, a large pressure is produced to compress on the brake fluid.*
Menggunakan minyak ringan. *Use light oil.*	Minyak ringan mempunyai kelikatan yang rendah dan boleh mengalir melalui saluran paip yang kecil dengan mudah. Oleh itu, ia boleh menghantar tekanan lebih cepat ke semua omboh roda. *Light oil has low viscosity and can flow through small pipe line easily. Thus, can transmit pressure faster to all the wheel's piston.*
Roda hadapan harus dipasang dengan brek cakera. *The front wheels should be fixed with disc brake.*	Kebanyakan daya brek diperlukan pada roda hadapan kenderaan kerana bahagian depan kenderaan jauh lebih berat. *Most of the braking force is required at the front wheels of the vehicle as the front part of the vehicle is much heavier.*
Roda belakang harus dipasang dengan brek dram. *The real wheels should be fixed with drum brake.*	Daya brek pada roda belakang harus sedikit lebih kecil daripada roda hadapan untuk kenderaan diperlahankan dengan lebih berkesan. *The braking force at rear wheels should be slightly smaller than the front wheels for vehicles to slow down more effectively.*

Sistem brek *P* adalah yang paling sesuai untuk kenderaan kecil dan ekonomi. Sistem brek itu adalah terdiri daripada silinder induk dengan omboh kecil, brek minyak ringan, roda hadapan dipasang dengan brek cakera dan roda belakang dipasang dengan brek dram.
Brake system P is the most suitable one for small and economical vehicles. The braking system consists of master cylinder with small piston, light oil brake fluid, disc brake front wheels and drum brake rear wheels.

(d) (i) Tekanan /*Pressure* = $\frac{5\text{ N}}{50\text{ cm}^2} = \frac{\text{Load/}\textit{Beban}}{100\text{ cm}^2}$
Maka/ *Therefore*,
Beban/ *Load* = 50 N
Jisim beban / *Mass of load* = $\frac{5\text{ N}}{10\text{ N kg}^{-1}} = 5\text{ kg}$

(ii) Isi padu bendalir yang dipindahkan,
Volume of fluid moved,
$V = 10\text{ cm}^2 \times 20\text{ cm}$
$= 100\text{ cm}^2 \times l$
$l = 2\text{ cm}$

Bahagian C

3. (a) Daya apungan adalah suatu daya bertindak ke atas akibat daripada objek yang terendam keseluruhan atau sebahagian dalam sesuatu bendalir.
Bouyant force is an upward force resulting from an object being wholly or partially immersed in a fluid.

(b) Berat bola keluli lebih besar daripada berat bola kayu.
The weight of steel ball is larger than the weight of wooden ball.
Jumlah air yang disesarkan oleh bola keluli dan bola kayu adalah sama.
The volume of water displaced by the steel ball and wooden ball is the same.
Daya apungan yang bertindak pada bola keluli dan bola kayu adalah sama.
The bouyant force acted on steel ball and wooden ball is the same.

(c) (i) Daya apungan bertambah dengan isi padu air yang disesarkan.
The buoyant force increases with the volume of water displaced.

(ii) Daya apungan bertambah dengan berat air yang disesarkan.
The buoyant force increases with the weight of water displaced.

(iii) Prinsip Archimedes / *Archimedes' principal*

(d) Ketumpatan bola keluli lebih besar daripada ketumpatan air. Berat bola keluli lebih besar daripada berat air yang disesarkan atau daya apungan. Oleh itu, bola keluli tenggelam. Ketumpatan bola kayu lebih kecil daripada ketumpatan air. Berat bola kayu lebih kecil daripada berat air yang disesarkan atau daya apungan. Oleh itu, bola kayu terapung.
The density of steel ball is larger than the density of water. The weight of steel ball is larger than the weight of water displaced or the buoyant force. Therefore, the steel ball sinks. The density of wooden ball is smaller than the density of water. The weight of wooden ball is smaller than the weight of water displaced or the buoyant force. Therefore, the wooden ball float.

(e)

Ciri-ciri *Characteristics*	**Keterangan** *Explanation*
Gantikan batang kayu dengan bahan yang ringan dan mempunyai ruang udara di dalamnya seperti buluh *Replace the wooden stick with material that is light and has air space in it such as bamboo.*	Supaya rakit dapat terapung dengan lebih berkesan di atas air. *So that the raft can float more effectively on water.*

Rakit itu harus dibina dengan dua lapisan buluh. *The raft should be built with double layer bamboo.*	Untuk meningkatkan keapungannya supaya rakit dapat menampung lebih daripada lapan orang tanpa tenggelam. *To improve its buoyancy so that it can carry slightly more than eight people without sinking.*
Bentuk rakit harus dalam bentuk larus. *The shape of the raft should be streamline*	Untuk mengurangkan rintangan air semasa gerakan. *So to reduce water resistance during motion.*
Lapisan buluh diikat dengan tali yang kuat. *The bamboo layer is tied securely with strong ropes.*	Hal ini adalah untuk mengelakkan rakit daripada berpecah semasa bergerak. *This is to prevent the raft from breaking up during motion.*
Motor harus dipasang pada satu hujung rakit. *A motor should be installed at one end of the raft.*	Supaya rakit dapat bergerak dengan mudah di air dengan kelajuan yang lebih tinggi. *So to make it move easily on water at higher speed.*

BAB 3

Elektrik
Electricity

3.1 Arus dan Beza Keupayaan
Current and Potential Different

2. daya, medan elektrik / *force, electric field*

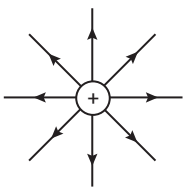
3. cas elektrik, daya / *electric charge, force*

4. medan elektrik, daya / *electric field, force*

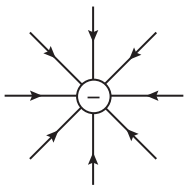
5. garis, anak panah, garis medan elektrik
lines, arrows, electric field line

6. ke luar, cas positif, ke dalam
outward, positive charge, inward

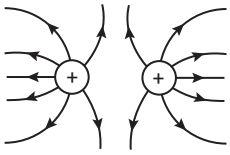
7. (a)



(b)



(c)



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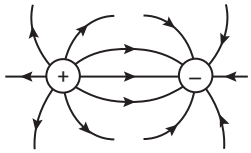

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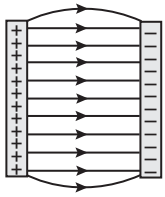
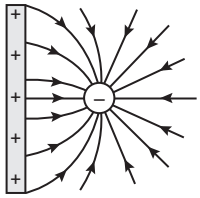


(f)



Kekuatan medan elektrik, *E*
Electric field strength, E

1. cas positif, medan elektrik / *positive charge, electric field*
besar / *larger* bertambah / *increases*

3. $E = \frac{F}{Q}$

E = Kekuatan medan elektrik, newton per coulomb / *Electric field strength, newton per coulomb*
F = Daya elektrik, newton / *Electric force, newton*
Q = Kuantiti cas elektrik, coulomb / *Quantity of electric charge, coulomb*

5. medan elektrik, tetap / *electric field, constant*

6. (a) Voltan *V,* tinggi, kuat, $E \propto V$
voltage V, higher, stronger, $E \propto V$

(b) Jarak pemisahan, besar, kecil, $E \propto \frac{1}{d}$
separation distance, greater, smaller, $E \propto \frac{1}{d}$

Di mana, / *Where,*
E diukur dalam / *is measured in* Volt per meter ($V\ m^{-1}$)
V diukur dalam / *is measured in* Volt (V)
d diukur dalam / *is measured in* meter (m)

7. $N\ C^{-1}$

$\frac{N\ m}{m\ C} = N\ C^{-1}$

Contoh 1

Q = 0.15 C

Daya / *Force* = 0.045 N

$E = \frac{0.045\ N}{0.15\ C}$ = 0.3 N C^{-1}

Kelakuan zarah bercas di dalam suatu medan elektrik
The behaviour of charge particles in electric fields

1. (a) positif, negatif, neutral, daya elektrik, seimbang
positively, negatively, neutral, electrical force, balanced
(b) positif, menolak, ditolak
positively, repel, pushed
(c) negatif, positif, negatif, plat-X, berulang-alik
negative, positive, negatively, plate-X, oscillates
(d) (i) voltan, kadar ayunan
voltage, rate of oscillation
(ii) kecil, besar / *smaller, higher*

Kesan suatu medan elektrik ke atas nyalaan lilin
The effect of electric field on candle flame

2. pecah, dua bahagian, bertentangan
split, two parts, opposite
(a) plat negatif, lebih besar / *negative plat, larger*
(b) mengionkan, ion positif, cas negatif, berat, besar, negatif, ringan, kecil, positif, lebih besar, ion positif, negatif, lebih ringan, lebih nipis, positif
ionises, positive ions, negative charges, heavier, larger, negative, lighter, smaller positive, larger, positive ions, negative , lighter, thinner positive

Arus Elektrik dan Beza Keupayaan
Electric Current and Potential Difference

Arus elektrik / *Electric current*

1. cas elektrik, per unit masa / *electric charges, per unit time*
2. *It,* jumlah cas elektrik, masa / *It, total electric charges, time*
3. ampere (A), 1 coulomb cas per saat / *ampere (A), 1 coulomb of charge per second*
1 A = 1 C s^{-1}

Contoh 1

(a) I = 0.8 A
t = 15 × 60 = 900 s
$Q = It$ = 0.8 × 900 = 720 C

Beza Keupayaan / *Potential difference*

1. tenaga, dipindahkan, per unit cas
energy converted, per unit charge
Volt (V) atau J C^{-1} / *Volt (V) or J C^{-1}*
2. Beza keupayaan, 1 Volt, 1 coulomb, 1 joule
potential difference, 1 Volt, 1 coulomb, 1 joule
1 V = 1 J C^{-1}

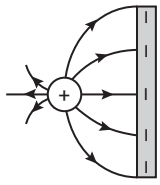
Contoh 2

$Q = It$
= 2.4 × 20
= 48 C

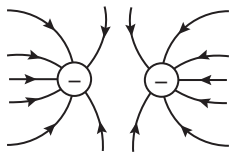
$W = VQ$
= 230 × 48
= 11 040 J

Tugasan 1

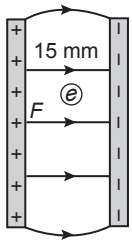
1. (a)



(b)



2. (a)



$E = \frac{F}{Q}$

$= \frac{7.2 \times 10^{-16}\ \text{N}}{1.6 \times 10^{-19}\ \text{C}}$

= 4.5 × 10^3 N C^{-1}

(b) $V = Ed$
= 4.5 × 10^3 N C^{-1} × 0.015 m
= 67.5 V

3.2 Rintangan
Resistance

2. nisbah beza keupayaan, V kepada arus, I
ratio of potential difference V to the current I
ohm (Ω)
3. 1 ohm, 1 volt, 1 ampere
1 ohm, 1 volt, 1 ampere
4. konduktor Ohm, konduktor bukan Ohm
ohmic conductor, non-ohmic conductor
5. linear, $V \propto I$, $\frac{V}{I}$ = pemalar, Hukum Ohm
linear, $V \propto I$, $\frac{V}{I}$ = pemalar, Ohm's law
6. tidak linear, tidak mematuhi / *not linear, does not obey*

Eksperimen 3.1

(I) Mengkaji hubungan *V* dengan *I* bagi dawai konstantan
To study the relationship between V and I for constantan wire

Pemboleh ubah / *Variable*:

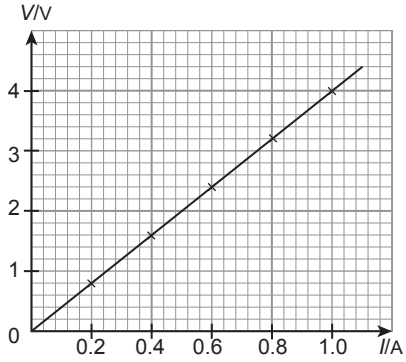
(a) Arus, *I* / *Current, I*

(b) Beza keupayaan, *V* / *Potential difference, V*

(c) Panjang dawai konstantan / *Length of constantan wire*

Keputusan / *Results*:

Graf *V* melawan *I*
Graph of V against I



1. satu garis lurus melalui asalan
   a straight line passing through the origin
2. berkadar langsung, arus, *I*, $V \propto I$
   directly proportional, current, I, $V \propto I$
3. suatu pemalar, rintangan
   a constant, resistance
4. pemalar, Hukum Ohm / *constant, Ohm's law*

(II) Mengkaji hubungan *V* dengan *I* bagi mentol berfilamen
To study the relationship between V and I for filament bulb

Pemboleh ubah / *Variable*:

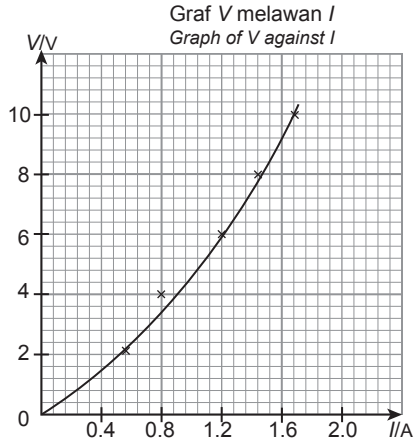
(a) Arus, *I* / *Current, I*

(b) Beza keupayaan, *V* / *Potential difference, V*

(c) Panjang filamen / *Length of filament*

Keputusan / *Results*:

Graf *V* melawan *I*
Graph of V against I



Perbincangan / *Discussion*:

1. garis melengkung / *curve line*
2. beza keupayaan, *V* tidak berkadar terus dengan arus, *I*
   the potential difference, V, is not proportional to current, I
3. bertambah, rintangan, bertambah, besar arus, tinggi suhu, bertambah, suhu, rintangannya
   increases, resistance, increases, greater the current, higher the temperature, increase, temperature, resistance

Menyelesaikan masalah bagi sambungan litar kombinasi bersiri dan selari
Solving problems involving combination of series and parallel circuit

Contoh 1

(a) $\frac{1}{R} = \frac{1}{15} + \frac{1}{10}$

$= \frac{2+3}{30} = \frac{5}{30}$

$R = 6\ \Omega$

$= 4\ \Omega + 6\ \Omega$

$= 10\ \Omega$

(b) $V = \frac{6}{4+6} \times 10\ V$

$= 6$ V

(10 V – 6 V) = 4 V

(c) $I = \frac{V}{R} = \frac{10}{10} = 1$ A

arus mengalir melalui perintang / *current passed through resistor* 4 Ω = 1 A

arus mengalir melalui perintang / *current passed through resistor* 15 Ω $= \frac{6}{15} = 0.4$ A

arus mengalir melalui perintang / *current passed through resistor* 10 Ω $= \frac{6}{10} = 0.6$ A

Maksud Kerintangan Dawai, ρ
The meaning of resistivity of wire, ρ

2. 1 m^3, 1 m, 1 Ω, 1 Ohm meter (Ω m)
   1 m^3*, 1 m, 1 Ω, 1 Ohm meter (Ω m)*
4. *R* = rintangan, ohm (Ω) / *resistance, ohm (Ω)*
   I = panjang, meter (m) / *length, meter (m)*
   A = luas keratan rentas, meter persegi (m^2) / *cross sectional area, meter square* (m^2)

TIP FIZIK

bukan / *is not*

- tidak bersandar, Ω m / *does not depend, Ω m*
- pengaliran arus, panjang, luas keratan bahan, *A,* Ohm (Ω)
  current flow, length, l, cross sectional area of the material, A, Ohm (Ω)

Eksperimen 3.2

(I) Mengkaji kesan panjang dawai, *l* ke atas rintangan
To study the effect of length of wire, l on resistance

Pemboleh ubah / *Variable*:

(a) Arus, *I* / *Current, I*

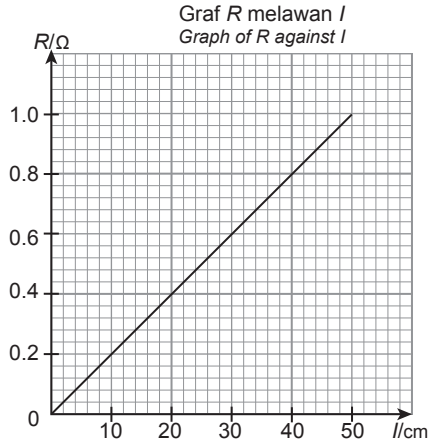
(b) Beza keupayaan, *V* / *Potential difference, V*

(c) Panjang dawai konstantan / *Length of constantan wire*

Keputusan / *Results*:

Rintangan *Resistance* **(Ω)**	0.2	0.4	0.6	0.8	1.0

Perbincangan / *Discussions:*



1. garis lurus, asalan, berkadar terus, $R \propto l$
straight line, origin, directly proportional, $R \propto l$

(II) Mengkaji kesan luas keratan rentas dawai, *A* ke atas rintangan
To study the effect of cross sectional area of wire, A on resistance

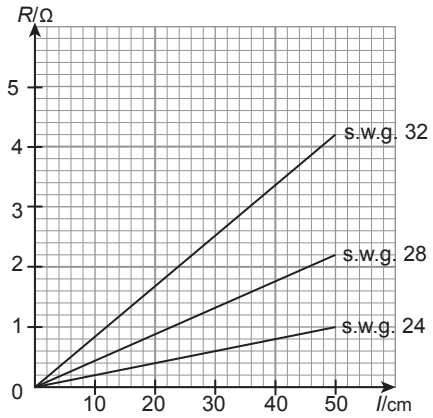
Keputusan dan perbincangan / *Results and discussion*:

Bahan: Dawai konstantan yang panjang 50 cm dan saiz s.w.g. 28.
Material: Constantan wire of length 50 cm, and size s.w.g. 28

Rintangan / *Resistance* (Ω)	0.4	0.9	1.3	1.8	2.2

Bahan: Dawai konstantan yang panjang 50 cm dan saiz s.w.g. 32.
Material: Constantan wire of length 50 cm, and size s.w.g. 32

Rintangan / *Resistance* (Ω)	1.0	1.7	2.5	3.4	4.2



rintangannya bertambah dengan saiz s.w.g, besar, besar rintangannya, kecil luas keratan rentas dawai, besar
resistance increases with the size s.w.g, larger, larger the resistance, smaller the cross sectional area, larger

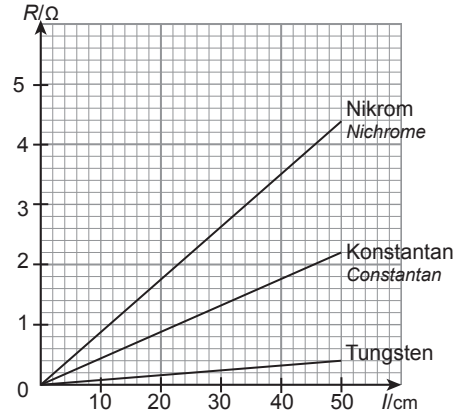
(III) Mengkaji kesan jenis bahan dawai, *ρ* ke atas rintangan
To study the effect of type of wire, ρ on resistance

Keputusan dan perbincangan / *Results and discussion*:
Dawai tungsten / *Tungsten wire*: s.w.g. 28, panjang / *length* 50 cm

Rintangan / *Resistance* (Ω)	0.05	0.10	0.15	0.20	0.25

Dawai nikrom / *Nichrome wire*: s.w.g. 28, panjang / *length* 50 cm

Rintangan / *Resistance* (Ω)	1.0	1.8	2.7	3.6	4.5



nilai yang berbeza, jenis, kerintangan, $R \propto \rho$
different values, type, resistivity, $R \propto \rho$

5.

Kesan panjang dawai, *l* ke atas rintangan, *R* ***The effect of length, l on resistance, R***	**Kesan luas keratan rentas dawai, *A* ke atas rintangan, *R*** ***The effect of cross-sectional area, A on resistance, R***	**Kesan jenis bahan dawai, *ρ* ke atas rintangan, *R*** ***Effect of material of wire, ρ on resistance, R***
Semakin panjang konduktor, semakin besar rintangannya. *The longer the conductor, the greater its resistance.*	Semakin besar luas keratan rentas konduktor, semakin kecil rintangannya. *The larger the cross-sectional area, the smaller its resistance.*	Konduktor yang diperbuat daripada bahan yang berbeza mempunyai rintangan yang berbeza. *Conductors made of different materials have different resistance .*

R = rintangan dawai / *resistance of wire* (Ω)

l = panjang dawai / *length of wire* (m)

A = luas keratan rentas dawai / *cross sectional area* (m^2)

ρ = kerintangan dawai / *resistivity of wire* (Ω m)

Aplikasi kerintangan dawai dalam kehidupan harian
The application of resistivity of wire in daily life

Elemen pemanas ***Heating elements***	**Pendawaian elektrik di rumah** ***Home electrical wiring***
• Mempunyai kerintangan tinggi supaya dapat menghasilkan lebih banyak haba walaupun arus yang rendah mengalir melaluinya. *It has high resistivity so that it produces more heat even if low current is flowing through it.* • Mempunyai takat lebur yang tinggi supaya tidak melebur walaupun pada suhu yang tinggi. *It has high melting point so that it does not melt even at high temperatures.*	• Terdiri daripada dawai kuprum atau aluminium (atau aluminium bersalut kuprum) yang halus. *Made up of fine wire of copper or aluminum (or copper-sheathed aluminum).* • Kuprum dan aluminium adalah konduktor elektrik yang baik dan mempunyai kerintangan yang kecil. *Copper and aluminium are good conductor of electricity and have small resistivity.*

Nilai kerintangan bahan konduktor, bukan konduktor, semikonduktor dan superkonduktor
Resistivity of conducting material, non-conductor, semiconductor, and superconductor

Bahan konduktor ***Conducting material***	**Bukan konduktor** ***Non-conductor***	**Semikonduktor** ***Semiconductor***	**Superkonduktor** ***Superconductor***
Mempunyai nilai kerintangan yang rendah. *Has a low resistivity.*	Mempunyai nilai kerintangan yan gtinggi. *Has a high resistivity.*	Mempunyai nilai kerintangan di antara konduktor dan bukan konduktor. *Has resistivity between conductor and non-conductor.*	Mempunyai kerintangan sifar pada suhu genting (20K hingga kurang daripada 1K. *Has zero resistivity at critical temperature (20K to below 1K).*
Konduktor elektrik yang baik. *Very good conductor of electricity.*	Penebat elektrik yang baik. *Very good insulator of electricity.*	Kekonduksian elektrik lebih baik daripada penebat tetapi kurang baik daripada konduktor. *Conductivity better than insulator but poorer than conductor.*	Kekonduksian elektrik yang baik tanpa rintangan. *Very good conductor of electricity without resistance.*
Contoh: Kuprum dan karbon *Example:* *Copper and carbon*	Contoh: Plastik dan getah *Example:* *Plastic and rubber.*	Contoh: Silikon dan germanium *Example:* *Silicon and germanium*	Contoh: Merkuri pada suhu 4.2 K dan cesium pada suhu di bawah 1.5 K *Example:* *Mercury at 4.2 K and caesium below 1.5 K*
Kegunaan / *uses*: Pendawaian elektrik dan elemen pemanas. *Electrical wiring and heating element.*	Kegunaan / *uses*: Penebat untuk dawai elektrik dan semua peralatan elektrik. *Insulator for electrical wire and devices.*	Kegunaan / *uses*: Membuat cips dan komponen elektronik. *Manufacturing chips and electronic component.*	Kegunaan / *uses*: Digunakan dalam MRI dan keretapi Maglev. *Used in MRI and Maglev train.*

Menyelesaikan masalah melibatkan rumus rintangan dawai, $R = \frac{\rho l}{A}$
Solving problems involving resistance of a wire formula, $R = \frac{\rho l}{A}$

Contoh 1

d = 0.5 mm, r = 0.25 mm

$A = \pi r^2 = 3.142 \times (0.25 \times 10^{-3})^2$
$= 1.96 \times 10^{-7}$ m^2

l = 15 m

R = 95 Ω

$$\rho = \frac{RA}{l} = \frac{95\ \Omega \times 1.96 \times 10^{-7}\ \text{m}^2}{15\ \text{m}} = 1.24 \times 10^{-6}\ \Omega\text{m}$$

Tugasan 2

1. (a) Rintangan berkesan / *Effective resistance*,

$$R = 8 + \frac{1}{\frac{1}{12} + \frac{1}{6}} = 12\ \Omega$$

(b) $I_1 = \frac{12}{12} = 1$ A;

$I_1 = I_2 + I_3$

$1 = I_2 + I_3$

$V_2 = V_3 \rightarrow I_2 \times 12 = I_3 \times 6$

$2I_2 = I_3$

$1 = I_2 + 2I_2$

$I_2 = 0.33$ A

$I_3 = 0.66$ A

(c) $V = IR = 1 \times 8 = 8$ V

3.3 Daya Gerak Elektrik (d.g.e) dan Rintangan Dalam
Electromotive Force (e.m.f) and Internal Resistance

Daya gerak elektrik (d.g.e.) *Electromotive force (e.m.f.)*	**Beza keupayaan** *Potential difference*
Voltmeter disambung merentasi terminal sel dalam litar terbuka. *The voltmeter is connected across the cell in the open circuit.* Tiada arus mengalir dalam litar. *There is no current flowing in the circuit.*	Voltmeter disambung merentasi mentol dan juga sel. *The voltmeter is connected across the bulb as well as the cell.* Arus mengalir dalam litar. *The current flows in the circuit.*
Bacaan voltmeter = 1.5 V ialah ukuran daya gerak elektrik (d.g.e.) sel atau beza keupayaan merentasi sel dalam litar terbuka (arus = 0). *Voltmeter reading = 1.5 V is a measure of the electromotive force (e.m.f.) of the cell or the potential difference across the cell in an open circuit (current = 0).*	Bacaan voltmeter = 1.2 V ialah ukuran beza keupayaan merentasi mentol dalam litar tertutup (arus mengalir dalam litar ≠ 0). *Volmeter reading = 1.2 V is the measure of the potential difference across the bulbs in a closed circuits (current flowing in circuits, I ≠ 0).* Beza keupayaan ini juga dikenali sebagai beza keupayaan terminal. *This potential difference is also known as terminal potential difference.*
D.g.e. suatu sumber elektrik ialah beza keupayaan merentasi sumber itu dalam litar terbuka. *E.m.f. of an electric source is the potential difference across the source in an open circuit.* Ia juga adalah jumlah tenaga yang dibekalkan kepada satu coulomb cas oleh satu sumber (sel kering atau bateri). *It is also the total energy supplied to a coulomb of charge by a source (dry cell or battery).*	Beza keupayaan terminal adalah tenaga yang dilesapkan oleh satu coulomb cas selepas melalui satu beban (mentol) dalam litar lengkap. *The terminal potential difference is the energy consumed by a coulomb of charge after passing through a load (bulb) in a complete circuit.*

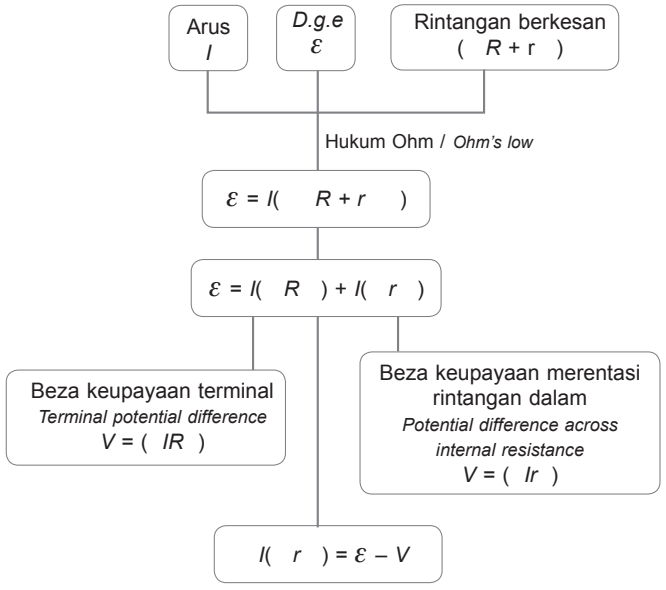
Rintangan dalam
Internal resistance

1. menyusut, rintangan dalam / *drops, internal resistance*

Kesan rintangan dalam terhadap susutan voltan
The effect of internal resistance to voltage drop

1. bersiri, sama / *series, same*

2.



Maksud istilah yang terlibat dalam daya gerak elektrik dan rintangan dalam
Meaning of terms involves in electromotive force and internal resistance

1. satu coulomb cas, satu coulomb cas
a coulomb of charge, a coulomb of charge

2. tindak balas kimia, dilesapkan
chemical reaction, dissipated

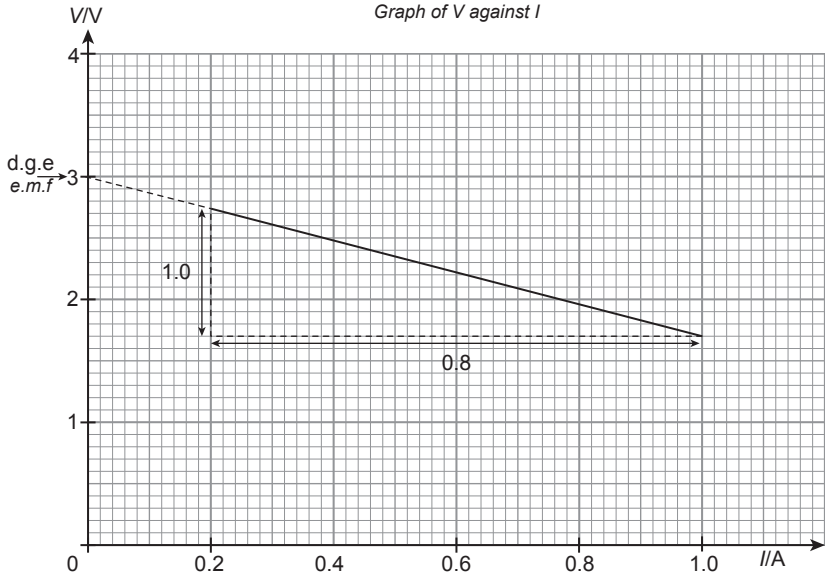
3. rintangan dalam / *internal resistance*

4. satu coulomb cas, $V = IR$ / *a coulomb of charge, V = IR*

Eksperimen 3.3

Keputusan / ***Results:***

Graf *V* melawan *I*
Graph of V against I



Daripada graf / *From the graph*:

- D.g.e. sel / *E.m.f. cell*:

  $\mathcal{E}$ = 3.0 V

- Rintangan dalam / *Internal resistance*:

  $r = \frac{2.7 - 1.7}{1.0 - 0.2} = \frac{1}{0.8}$

  = 1.25 Ω

Perbincangan / ***Discussion*:**

1. $\mathcal{E} - V = Ir, -Ir + \mathcal{E}$, kecerunan negatif
   $\mathcal{E} - V = Ir, -Ir + \mathcal{E}$, *negative gradient*
2. tiada arus, daya gerak elektrik (d.g.e.) sel
   no current, electromotive force (e.m.f.)
3. kurang, *Ir*, 'voltan hilang', rintangan dalam, *r*
   less, Ir, 'voltage drop', internal resistance, r

Membandingkan magnitud arus dalam litar untuk susunan bateri sesiri dan selari
To compare the magnitude of the current in the circuit for batteries in series and in parallel

1.

Sel kering secara sesiri *Dry cells in series*	**Sel kering secara selari** *Dry cells in parallel*
D.g.e. berkesan / *Effective e.m.f.,* $\mathcal{E}$ = 2 V + 2 V = 4 V	D.g.e. berkesan / *Effective e.m.f.* $\mathcal{E}$ = 2 V
Rintangan dalam berkesan / *Effective internal resistance,* r = 0.5 Ω + 0.5 Ω = 1.0 Ω	Rintangan dalam berkesan / *Effective internal resistance* $\frac{1}{r} = \frac{1}{0.5} + \frac{1}{0.5} = 4$ Maka, $r = \frac{1}{4}$ = 0.25 Ω
Jumlah rintangan dalam litar / *Total resistance in the circuit* R_T = 4 Ω + 1 Ω = 5 Ω	Jumlah rintangan dalam litar / *Total resistance in the circuit* R_T = 4 Ω + 0.25 Ω = 4.25 Ω
Arus maksimum dalam litar / *Maximum arus dalam litar* $I = \frac{V}{R} = \frac{4}{5}$ = 0.8 A	Arus maksimum dalam litar / *Maximum current in the circuit* $I = \frac{V}{R} = \frac{2}{4.25}$ = 0.47 A
Beza keupayaan terminal / *Terminal potential difference* $V = IR$ = 0.8 × 4 = 3.2 V Voltan 'hilang / *Voltage drop* $V' = Ir$ = 0.8 × 1.0 = 0.8 V	Beza keupayaan terminal / *Terminal potential difference* $V = IR$ = 0.47 × 4 = 1.88 V Voltan 'hilang' / *Voltage drop* $V' = Ir$ = 0.47 × 0.25 = 0.12 V

2. Jumlah rintangan dalam litar = $R + r$
= 4 Ω + 0.5 Ω
= 4.5 Ω

Arus dalam litar, $I = \frac{V}{R} = \frac{2\text{ V}}{4.5\ \Omega}$

= 0.44 A

Beza keupayaan terminal / *Terminal potential difference*
$V = IR$ = 0.44 × 4 = 1.8 V

Voltan hilang / *voltan drop*
$V' = Ir$ = 0.44 × 0.5 = 0.2 V

3.
- paling cerah, paling besar / *brightest, largest*
- lebih cerah, lebih kecil, lebih besar
  brighter, is smaller, larger
- lebih kecil, lebih kecil, tahan lebih lama
  smaller, smaller, can last longer

Sambungan Sel Suria dan Bateri dalam Kereta Elektrik
Connecting Solar Cell and Battery in Electric Car

1. sel fotovolta, mengubah, tenaga elektrik
   photovoltaic cells, transform, electrical energy
2. semikonduktor, tenaga elektrik, cahaya
   semiconductor, electricity, light
3. panel suria, secara bersiri, selari
   solar panel, in series, in parallel

5. pek bateri, elektrik, enjin
battery packs, electric, engine

6. bateri, dicaskan semula */ battery, recharged*

7. tahan lama, arus yang tinggi / *durable, high current*

Menyelesaikan masalah melibatkan d.g.e. dan rintangan dalam bagi sel kering
Solving problem involving e.m.f. and internal resistance in dry cells

Contoh 1

(a) $\mathcal{E} = 2 \times 1.5 \text{ V} = 3.0 \text{ V}$

(b) = 5.0 / r = 0.2 Ω
Jumlah rintangan dalam litar = (R + r)
= (5 + 0.2) Ω = 5.2 Ω

(c) 3.0 = I × 5.2

$I = \frac{3.0}{5.2} = 0.577$ A

I = 0.58 A
$V = IR$
V = 0.577 × 5 = 2.88 V = 2.9 V

(d) $Ir = 0.58 \times 0.2 = 0.12$ V

Tugasan 3

1. (a) $\mathcal{E} = I(R + r)$
6 = 0.5(R + 0.2)
R = 11.8 Ω

(b) $V = IR$
= 0.5 × 11.8
= 5.9 V

(c) Voltan hilang / *Voltage drop* = $\mathcal{E} - V$
= 6 – 5.9 = 0.1 V
atau / *or*
$V' = Ir$ = 0.5 × 0.2 = 0.1 V

2. (a) $\mathcal{E} = V + Ir$
12 = V + (0.5 × 1.2)
V = 12 – 0.6
= 11.4 V

(b) $V = IR$
11.4 = 0.5 × R
R = 22.8 Ω

3.4 Tenaga Elektrik dan Kuasa
Electrical Energy and Power

Hubungan antara tenaga elektrik (*E*), voltan (*V*), arus (*I*) dan masa (*t*)
Relationship between electrical energy (E), voltage (V), current (I) and time (t)

1. Daripada definisi beza keupayaan, V, yang berkaitan dengan tenaga elektrik yang dilesapkan seunit cas.
From the defination of potential difference related to electrical energy dissapated se unit charge.
⇒ $V = \frac{E}{Q}$

Susun semula / *Rearrange* ⇒ Tenaga elektrik / *Electrical energy* $E = V \times Q$

Daripada definisi arus, I, yang berkaitan dengan kadar pengaliran cas.
From the defination of electric current related to rate of flowing charge.
⇒ $I = \frac{Q}{t}$

Susun semula / *Rearrange* ⇒ Cas elektrik / *Electrical charge* $Q = I \times t$

Maka, hubungan antara *Thus, relationship between* E, V, I dan / *and* i ⇒ Tenaga elektrik / *Electrical energy* $E = V \times I \times t$

Daripada Hukum Ohm / *From Ohm's law* ⇒ $V = IR$

$E = IR \times I \times t$
$= I^2 \times R \times t$

$I = \frac{V}{R} = \frac{V^2}{R} \times t$

Hubungan antara kuasa (*P*), voltan (*V*) dan arus (*I*)
The relationship between power (P), voltage (V) and current (I)

1.

Daripada definisi kuasa yang berkaitan dengan kadar tenaga yang dipindahkan,
From the defination of power that related to rate of energy transfer.

$$\text{Kuasa, } P = \frac{E}{t}$$

Ganti $E = VIt$ ke dalam sebutan kuasa P
Subtitute $E = VIt$ in term of power P

$$P = \frac{VIt}{t} = V \times I$$

Dari Hukum Ohm, $V = IR$,
Ganti ke dalam kuasa P
From Ohm's law, $V = IR$
Substitute into power P

$$P = IR \times I$$
$$= I^2R$$

Ganti arus, $I = \frac{V}{R}$
ke dalam kuasa P
Substitute current, $I = \frac{V}{R}$
into power P

$$P = V \times \frac{V}{R}$$
$$= \frac{V^2}{R}$$

Menyelesaikan masalah dalam kehidupan harian yang melibatkan tenaga dan kuasa elektrik
Solving problems in daily life involving electrical energy and power

Contoh 1

(a) $P = VI = 240 \times 4 = 960$ W
(b) $= 960 \times 5 \times 60$
$= 288\,000$ J $= 288$ kJ

Membandingkan kuasa dan kadar penggunaan tenaga pelbagai alatan elektrik
To compare the power and rate of energy consumption of various electrical appliances

1. Kadar kuasa dalam kW × bilangan unit × jam sehari × 30 hari
Power rating in kW × Number of unit × hours per day × 30 days

Jumlah tenaga elektrik digunakan sebulan ***Total electrical energy used per month***
0.15 kW × 24 j × 30 =108 kWj / kWh
0.7 kW × 1 j × 30 = 21 kWj / kWh
0.055 kW × 8 j × 30 = 13.2 kWj / kWh
1.5 kW × $\frac{1}{2}$ j × 30 = 22.5 kWj / kWh
1.5 kW × 12 j × 30 = 540 kWj / kWh
0.06 kW × 36 j × 30 = 64.8 kWj / kWh
0.075 kW × 8 j × 30 = 18 kWj / kWh
802.5 kWj / kWh

2. RM43.60, RM33.40, RM154.40, RM110.56, RM341.96

3. **1.** Mengurangkan masa / *Reduce the time*
2. Mengganti / *Replacing*
3. alat kawalan jauh, beban terus berjalan / *loads are continuously running*
4. cekap tenaga / *energy-efficient*
5. mematikan / *turn off*

Langkah penjimatan penggunaan tenaga elektrik di rumah
Steps to save on home electricity consumption

1. kecekapan tenaga / *energy efficient*
2. mentol cekap tenaga / *energy-efficient bulbs*
3. tingkah laku, suis dimatikan / *behavior, switch is turned off*
4. berkuasa tinggi, dilakukan secara manual / *high-power, can be done manually*
5. termostat, mematikan, mengurangkan pemanasan, penyejukan
thermostat, turn off, reduce heating, cooling

Tugasan 4

1. (a) $E = VIt = 1.5 \times 0.2 \times 0.5 \times 60 \times 60$ J $= 540$ J
(b) $P = VI = 1.5 \times 0.2 = 0.3$ W

2. (a) $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{240^2}{1500} = 38.4\ \Omega$

(b) $I = \frac{P}{V} = \frac{1500}{240} = 6.25$ A

3. (a) $P_5 : P_{15} = \frac{9^2}{5} : \frac{9^2}{15} = 3 : 1$

(b) Kuasa output / *Power output* $= \frac{9^2}{5} + \frac{9^2}{15} = 21.6$ W

4. Jumlah penggunaan tenaga elektrik sehari / *Electrical energy consumed per day*
= 1.0 kW × 6 j = 6 kWj

Maka, jumlah penggunaan tenaga elektrik dalam 1 bulan / *Therefore, total energy consumed in 1 month*
= 6 kWj × 30 = 180 kWj

Kos penggunaan elektrik / *The cost of using electricity*
= 180 × 0.24 = RM43.20

PRAKTIS SPM 3

Soalan Objektif

1. C **2.** A **3.** B **4.** C **5.** A

Soalan Struktur

Bahagian A

1. (a) Medan elektrik ialah suatu kawasan sekitar suatu zarah bercas di mana sebarang cas elektrik yang berada dalam kawasan tersebut akan mengalami daya elektrik.
Electric field is a region around a charged particle where any electric charge in the region will experience an electric force.

(b) (i) Nyalaan lilin pecah kepada dua bahagian. Bahagian lebih besar bergerak ke arah plat negatif dan bahagian kecil bergerak ke arah plat positif.
The candle flame splits into two portions. The larger portion moves towards the negative plate and the smaller portion moves towards the positive plate.

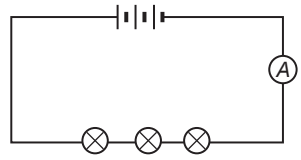
(ii) Nyalaan lilin mengionkan molekul-molekul udara kepada ion-ion positif dan ion-ion negatif. Ion-ion positif yang lebih besar dan lebih berat, tertarik ke arah plat negatif. Ion-ion negatif yang lebih kecil dan ringan tertarik ke arah plat positif.
The candle flame ionises the air molecules to positive and negative ions. The positive ions which are much larger and heavier are attracted towards the negative plate. The negative ions which are much smaller and lighter are attracted towards the positive plate.

(c) (i) $1.5 = I\,(5.0 + 0.5)$
$I = 0.27$ A

(ii) $$\frac{1}{R} = \frac{1}{5.0} + \frac{1}{10.0} = \frac{2+1}{10}$$
$$R = \frac{10}{3} = 3.33\ \Omega$$
$1.5 = I(3.33 + 0.5)$
$I = 0.39$ A

Bahagian B

2. (a) (i) Arus terus/ *Direct current*
(ii) Sambungan sesiri/ *Series connection*
(iii)



(b)

Ciri-ciri *Chracteristics*	Keterangan *Explanation*
Sel kering disambungkan secara sesiri *Dry cell is connected in series*	Untuk mendapat jumlah d.g.e. sebanyak 4.5 V *To obtain an e.m.f of 4.5 V*
Mentol-mentol disambungkan secara selari. *The bulbs are connected in parallel*	Lampu suluh masih berfungsi jika salah satu mentol terbakar *The torchlight can still operate if one of the bulb is blown*
Terminal positif disambungkan kepada terminal negatif sel yang satu lagi. *The positive terminal is connected the negative terminal of another cell*	Membolehkan pengaliran arus elektrik *The enable the flow of electric current*
Perintang disambungkan secara sesiri dengan mentol *The resistor is connected in series with the bulbs*	Melaraskan beza keupayaan merentasi mentol kepada 3 V supaya mentol-mentol itu bernyala dengan kecerahan normal. *To adjust the potential difference across the bulbs to 3 V so that the bulbs can light up with normal brightness.*
Litar *Q* adalah yang paling sesuai. Dalam Litar *Q*, sel-sel disambungkan secara sesiri, mentol-mentol disambungkan secara selari, terminal positif sel disambungkan kepada terminal negatif sel yang satu lagi, perintang disambungkan secara sesiri dengan mentol. *Circuit Q is the most suitable. In circuit Q, the cells are connected in series, the bulbs are connected in paralled, the positive terminal of the cell are connected to the negative terminal of another, the resistor is connected in series with the bulbs.*	

(c) (i) 12 V
(ii) $E = I(R + r)$
$12 = I\,(6 + 1)$
$I = 1.714$ A
(iii) $E = I(R + r)$
$12 = I\,(4 + 1)$
$I = 2.4$ A

Bahagian C

3. (a) Kadar pengaliran cas
The rate of flow charge.

(b)
- Bacaan ammeter dalam kedua-dua rajah adalah sama.
The ammeter reading both diagram are equal.
- Mentol dalam Rajah 3(a) lebih cerah berbanding mentol dalam Rajah 3(b)
The bulb in Diagram 3(a) is brighter than Diagram 3(b)
- Ketebalan gelungan dalam Rajah 3(a) lebih nipis berbanding dalam Rajah 3(b)
The thickness of the coil in Diagram 3(a) is thinner than that of in Diagram 3(b)
- Semakin nipis filamen semakin cerah mentol.
The thicker the coil the brighter the bulb.
- Semakin nipis filamen semakin besar jumlah haba yang dibebaskan.
The thinner the filament the greater the amount of heat released.

(c) (i) Hukum Ohm tidak dipatuhi. *V* tidak berkadar terus dengan *I*.
Ohm's law is not obeying. V is not directly proportional to I.
(ii) Suhu filamen bertambah apabila arus elektrik bertambah. Rintangan filamen bertambah apabila suhu bertambah.
The temperature of the filament increasing as the current increasing.
Resistance of the filament increases when the temperature increases.

(d)

Cadangan ***Suggestion***	**Keterangan** ***Explanation***
Ketumpatan yang rendah *Low density*	Mengurangkan jisim keseluruhan *Reduce the overall mass*
Takat lebur tinggi *High melting point*	Tahan suhu tinggi *Withstand high temperature*
Kadar pengoksidaan rendah *Low rate of oxidation*	Tidak mudah berkarat dan terbakar *Does not rust and get burnt easily*
Kerintangan tinggi *High resistivity*	Meningkatkan kadar haba yang dibebaskan *Increase the rate of heat released*
Dalam bentuk gegelung *In the form of coils*	Rintangan dawai bertambah kerana panjang dawai dalam elemen pemanas bertambah *The resistance increases since the length of wire in the heating element is increase*

(e) (i) 12 V
(ii) $E = I(R + r)$
$12 = I(6 + 1)$
$I = 1.714$ A
(iii) $E = I(R + r)$
$12 = I(4 + 1)$
$I = 2.4$ A

BAB 4

Keelektromagnetan
Electromagnetism

4.1 Daya ke atas Konduktor Pembawa Arus dalam suatu Medan Magnet
Force on a Current-carrying Conductor in a Magnetic field

Kesan suatu konduktor pembawa arus dalam suatu medan magnet
Effect on a current-carrying conductor in a magnetic field

Pemerhatian dan perbincangan / *Observation and discussion:*
Langkah 2 / *Step 2*
kanan / *right*

3. (a) kiri, *left*
(b) kanan, *right*

Perbincangan / *Discussion*:
1. arus, daya / *current, force*
2. medan magnet, gerakan, disongsangkan
magnetic field, motion, reversed

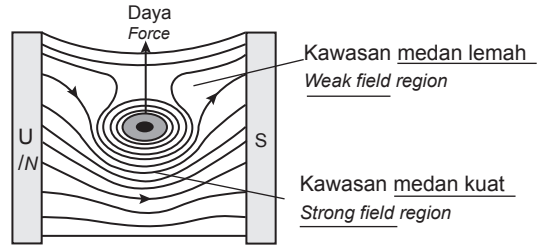
Corak medan magnet paduan
The pattern of the resultant magnetic field

1. medan paduan, medan lastik
resultant field, catapult field

2.

Garis medan membulat disebabkan oleh arus dalam dawai lurus. *The circular field lines due to current in a straight wire.*	Garis medan lurus disebabkan oleh dua magnet magnadur. *The straight field lines due to two magnadur magnets.*	Medan magnet paduan atau medan lastik. *The resultant magnetic field or the catapult field.*

3.



4. Arah tindakan daya, Petua Tangan Kiri Fleming
The direction of this force, Fleming Left Hand Rule

5. berserenjang / *perpendicular*

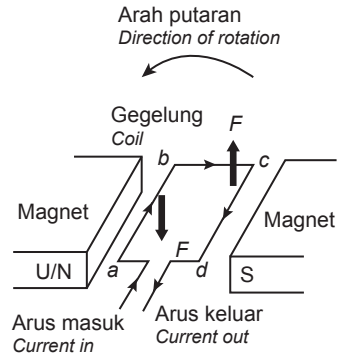
Faktor yang mempengaruhi magnitud daya yang bertindak ke atas konduktor pembawa arus dalam suatu medan magnet
Factors affecting the magnitude of the force acting on a current-carrying conductor in a magnetic field

Aktiviti 4.2

Perbincangan / *Discussion*:
1. • Menambahkan magnitud arus. / *Increase the size of current*
• Menambahkan kekuatan medan magnet. / *Increase the strength of the magnetic field.*
2. • d.g.e. / *e.m.f.*
• lebih tebal / *thicker*
• lebih pendek / *shorter*
• banyak lilitan / *many turns*
3. • lebih kuat / *more powerful*
• lebih dekat / *closer*

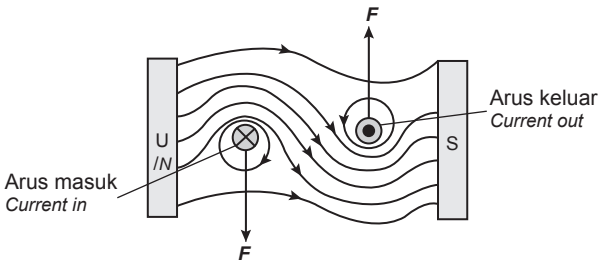
Kesan gegelung pembawa arus dalam medan magnet
Effect of current carrying coil in magnetic field

1.



3. medan magnet kekal, gegelung pembawa arus
permanent magnetic field, current carrying coil

4.



6. (a) arus , / *the current* ,
(b) bilangan lilitan dalam gegelung, / *the number of turns in the coil,*
(c) luas gegelung, / *the area of the coil,*
(d) kekuatan medan magnet. / *the strength of the magnetic field.*

Prinsip kerja motor arus terus
Working principle of a direct current motor

1. arus, gegelung, arah bawah, daya ke atas
the current, the coil, downward force, upward force

2. arah jam, Arus, inersia, terus berputar
clockwise, current, continue to rotate

3. menyongsangkan arus, daya ke atas, daya ke bawah, arah ikut jam
reverses, upward force, downward force, clockwise

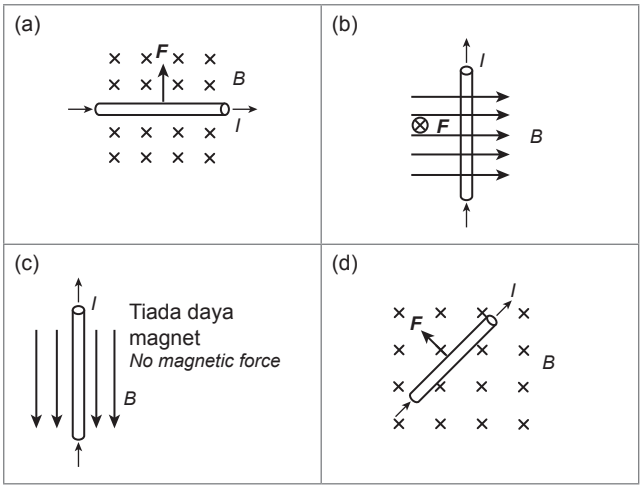
4. menyongsangkan arah arus, satu arah
reverse the direction of the current, one direction

Faktor yang mempengaruhi kelajuan putaran suatu motor elektrik
Factors that affect the speed of rotation of an electric motor

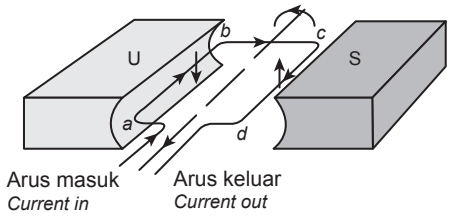
1.
- bilangan lilitan / *number of turns*
- magnitud arus atau voltan / *magnitude of current or voltage*
- medan magnet / *magnetic field*

Tugasan 1

1.



2.



3. (a) Daya bertindak ke bawah. / *The force acts downwards.*
(b) Daya bertindak ke bawah. / *The force acts downwards.*
(c) Tiada perubahan / *No change.*

4.2 Aruhan Elektromagnet
Electromagnetic Induction

Aruhan elektromagnet dalam suatu dawai lurus dan solenoid
Electromagnetic induction in a straight wire and solenoid

Aktiviti, pemerhatian dan penjelasan:
Activities, observations and explanation:

Pemerhatian dan penjelasan ***Observation and explanation***
Jarum tidak terpesong menunjukkan tiada arus mengalir dalam dawai. *No deflection occurred to the pointer showing that no current flows through the wire.*
Jarum terpesong ke sebelah menunjukkan arus mengalir dalam dawai. *The pointer is deflected to one side showing current flows through the wire.*
Jarum terpesong ke sebelah bertentangan menunjukkan arus mengalir dalam arah bertentangan. *The pointer deflected to the opposite side showing that thecurrent flows in the opposite direction .*
Pesongan jarum lebih besar ke sebelah kiri dan kanan menunjukkan arus lebih besar mengalir secara berulang alik. *The deflection of the pointer is larger to the left and to the right showing a larger current flows alternately.*
Tiada pesongan berlaku pada jarum galvanometer menunjukkan tiada arus mengalir. *No deflection to the pointer showing that no current flows.*
Tiada pesongan berlaku pada jarum galvanometer menunjukkan tiada arus mengalir. *No deflection to the pointer showing that no current flows.*
Pesongan jarum lebih besar diperhatikan menunjukkan arus lebih besar mengalir dalam dawai. *A larger deflection of the pointer is observed showing that larger current flows in the wire.*
Pesongan jarum lebih besar diperhatikan menunjukkan arus lebih besar mengalir dalam dawai. *A larger deflection of the pointer is observed showing that larger current flows in the wire.*

Aktiviti 4.4

2. (a) terpesong, arus / *deflected, current*
(b) terpesong, arus, bertentangan / *deflected, current, opposite*

(c) Tiada pemesongan, tiada arus / *No deflection, no current*
(d) terpesong, arus / *deflected, current*
(e) terpesong, arus, bertentangan / *deflected, current, opposite*

Perbincangan / *Discussion*:

1. garis medan magnet (fluks magnet), teraruh, arus
magnetic field lines (magnetic flux), induced, current

2. Gerakan, memotong / *Motion, cuts* → D.g.e teraruh / *E.m.f. induced* → arus teraruh / *induced current*

3. Tiada d.g.e. teraruh, tidak dipotong
No e.m.f. is induced, not cut

4. mendekati atau menjauhi, dipotong
towards or away, is cut

5. pemesongan, arus aruhan
deflection, induced current

Aruhan elektromagnet
Electromagnetic induction

1. daya gerak elektrik (d.g.e.) teraruh, konduktor, medan magnet
induced electromotive force (e.m.f.), conductor, magnetic field

2.
- bertambah / *increases*
- bertambah / *increases*
- bertambah / *increases*
- bertambah / *increases*
- bertambah / *increases*

Hukum Faraday / Faraday's Law

1. Hukum Faraday / *Faraday's Law*
Magnitud, berkadar langsung, pemotongan
magnitude, direclty proportional, cutting

Arah arus aruhan dalam dawai lurus
The direction of induced current flow in a straight wire

1. Petua Tangan Kanan Fleming / *Fleming's right-hand rule*

2.
- arah medan magnet / *direction of magnetic field*
- arah pergerakan konduktor dawai / *direction of movement of conductor wire*

Rajah 4.11 / *Diagram 4.11*

1. Ibu jari : Daya / *Thumb: Force (F)*

2. Jari telunjuk: Medan magnet / *First finger: Magnetic field (B)*

3. Jari tengah: Arus aruhan / *Second finger: Induced current (I)*

3. tiada arus aruhan, bersudut tegak
parallel, no induced current, perpendicular

Hukum Lenz / Lenz's Law

1. bertentangan / *oppose*

Aplikasi hukum Lenz dalam solenoid
Application of Lenz's law in solenoid

Apabila magnet ditolak ke dalam solenoid, dari Hukum Lenz, arus aruhan menghasilkan kutub Utara di sebelah kanan gegelung untuk menentang kutub Utara yang masuk. Menggunakan Petua Genggaman Tangan Kanan, arus aruhan akan mengalir melawan arah lawan jam dan penunjuk terpesong ke kanan.
When a magnet is pushed into the solenoid, from Lenz's law, an induced current produces a North pole on the right side of the coil to oppose the incoming North pole. Using Right Hand Grip Rule, the induced current will flow anticlockwise and the pointer deflects to right.

Mengikut Hukum Lenz, apabila magnet ditarik keluar dari solenoid, arus aruhan menghasilkan kutub Selatan di sebelah kanan gegelung untuk menentang kutub Utara yang keluar. Menggunakan Petua Genggaman Tangan Kanan, arus aruhan akan mengalir mengikut arah jam dan penunjuk terpesong ke kiri,
Based on Lenz's law, when a magnet is withdrawn from the solenoid, the induced current produces a South pole on the right side of the coil to oppose the outgoing North pole . Using Right Hand Grip Rule, the induced current will flow clockwise and the pointer deflects to the left.

Struktur dan fungsi kerja penjana arus terus dan penjana arus ulang-alik
Structure and function of direct-current generator and alternating current generator

1. aruhan elektromagnet / *electromagnetic induction*

2. (a) medan magnet / *magnetic fields*
(b) berus karbon, menukar arah, mengikut arah yang sama / *carbon brush, change its direction, in the same direction*
(c) Berus karbon, gegelung yang berputar, litar luar / *carbon brush, rotating coil, external circuit*
(d) memotong, arus aruhan / *cuts, induced current*
(e) satu arah / *one direction*
(f) medan magnet / *magnetic fields*
tanpa mengubah arah alirannya / *without changing its direction of flow*
(g) Berus karbon, gegelung yang berputar, litar luar / *carbon brush, rotating coil, external circuit*
(h) memotong, arus aruhan / *cuts, induced current*
(i) berulang-alik / *alternating*

Kaedah menukar fungsi motor menjadi dinamo
Method of changing the function of motor to dynamo

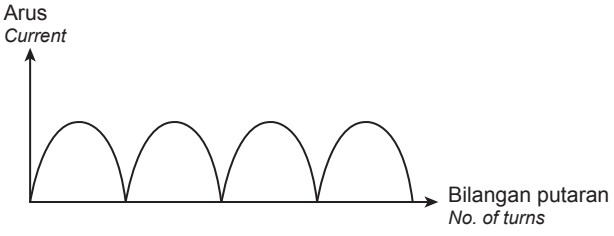
1. tenaga elektrik, mekanikal, tenaga elektrik / *electrical energy, mechanically, electricity*

2. beban elektrik (mentol), diputarkan secara mekanikal / *load (bulb), is rotated mechanically*

Tugasan 2

1. (a) A – kutub selatan / *south pole*; B – kutub utara / *north pole*
(b) Komutator.
Fungsi : Mengubah arah arus output untuk setiap putaran separuh gegelung, supaya arus dalam litar luar sentiasa mengalir dalam arah yang sama.
Commutator.
Function: To switch the direction of the output current every half rotation of the coil, so that the current in the outside circuit always flows in the same direction.

(c)



4.3 Transformer
Transformer

Prinsip kerja transformer ringkas
Working principle of a simple transformer

1. (a) voltan a.u. V_p / *AC voltage* V_p
(b) medan magnet, berubah secara berterusan / *continuous changing magnetic field*
(c) d.g.e. V_s berulang-alik, gegelung sekunder, arus teraruh I_s *alternating e.m.f.* V_s, *secondary coil, induced current* I_s

2.

Transformer injak-naik *Step-up transformer*	Transformer injak-turun *Step-down transformer*
Meningkatkan voltan output, V_s *To raise the output voltage,* V_s	Menurunkan voltan output, V_s *To lower the output voltage,* V_s
$N_s > N_p$	$N_s < N_p$
$V_s > V_p$	$V_s < V_p$
$I_s > I_p$	$I_s > I_p$

Maksud transformer unggul
The meaning of ideal transformer

1. kehilangan kuasa, primer, sekunder */ no power loss, primary, secondary*
3. 100%
4. Maka / *Therefore*, $\frac{N_p}{V_p} = \frac{N_s}{V_s}$ atau / *or* $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

Begitu juga / *So*, $\frac{I_p}{I_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$

Contoh 1

Kecekapan / *Efficiency*, η

$= \frac{\text{kuasa output / } \textit{output power}}{\text{kuasa input / } \textit{input power}} \times 100\%$

$= \frac{V_s I_s}{V_p I_p} = \frac{6000 \times 0.20}{240 \times 6.25} \times 100\%$

$= 80\%$

Punca kehilangan tenaga dan cara untuk meningkatkan kecekapan transformer
Cause of energy loss and ways to improve the efficiency of transformer

(a) Kesan pemanasan arus, rintangan, haba / *heating effect, resistance, heat*
(b) pemanasan, arus pusar / *heating, eddy current*
(c) pemagnetan, penyahmagnetan, memanaskan / *magnetising, demagnetising, heats up*
(d) tidak melalui / *do not pass through*
(e) lebih tebal, konduktor / *thicker, conductor*
(f) teras besi berlamina, arus pusar / *laminated core, eddy current*
(g) besi lembut, dimagnetkan, dinyahmagnetkan, sedikit tenaga / *soft iron, magnetized, demagnetised, less energy*
(h) gegelung primer / *primary coil*

Kegunaan dapur aruhan
The use of induction cooker

1. arus pusar / *eddy currents*
2. gegelung, arus pusar, memanaskan, makanan / *coil, eddy current, heats up, the food*

Kegunaan transformer dalam kehidupan harian
The use of transformers in daily life

1. injak naik, injak turun / *step-up, step-down*
2. injak-turun, rendah / *Step-down, low*

Sistem penghantaran dan pengagihan tenaga elektrik
Transmission system and distribution of electricity

1. kehilangan kuasa, rintangan / *power loss, resistance*
2. • lebih tebal, berat, kos pembinaan / *thicker, weight, construction costs*
• tinggi, lebih rendah, lebih rendah, injak naik / *high, lower, lower, step-up.*
3. (a) injak-naik / *step-up*
(b) voltan tinggi / *High voltage*
(c) injak-turun, menurunkan / *Step-down, step down*

Tugasan 3

1. (a) $I_s = \frac{P}{V} = \frac{24}{12} = 2$ A

(b) Tiada kuasa hilang / No power loss

$V_p I_p = V_s I_s$

$I_p = \frac{12}{220} \times 2 = 0.11$ A

PRAKTIS SPM 4

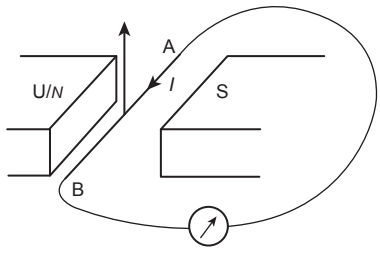
Soalan Objektif

1. B **2.** B **3.** B **4.** D **5.** C

Soalan Struktur

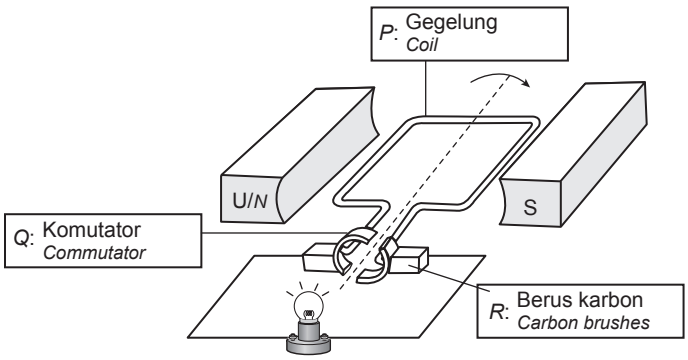
Bahagaian A

1. (a)



(i) Apabila dawai memotong medan magnet, d.g.e. teraruh dihasilkan dan seterusnya menghasilkan arus teraruh.
When the wire cuts the magnetic field, induced e.m.f. is produced and thus produces the induced current.
(iii) – Laju gerakan relatif dawai / *Speed of relative motion of the wire,*
– Kekuatan medan magnet / *Strength of magnetic field*

(b)



(i) Komponen *Q* ialah komutator jenis gelang terbelah yang sentiasa menukar sentuhan dengan berus karbon *R pada* setiap separuh putaran gegelung supaya arus aruhan ulang-alik yang terhasil dari gegelung dapat menukar arah setiap separuh putaran gegelung. Dengan ini, arus yang keluar dari gegelung sentiasa mengikut arah yang sama.
Component Q is a split ring commutator which always changes contact with carbon brush R for every half-cycle of the turning coil so that the alternating induced current from the coil can change its direction every half cycle. Thus, the output current always flows in the same direction.
Komponen R ialah berus karbon yang memastikan sentuhan elektrik yang baik antara gegelung yang berputar dengan litar luar.
Component R is a carbon brush that makes good electrical contact between the rotating coil and the external circuit.

Bahagian B

3. (a) (i) Transformer injak naik
Step-up transformer.

(ii)
- Arus ulang-alik menghasilkan medan magnet yang berubah-ubah dalam gegelung primer.
An alternating current produces changing magnetic field in the primary coil.
- Arus ulang-alik mengalir dalam gegelung primer.
Alternating current flows through the primary coil.
- Medan magnet yang berubah-ubah memotong gegelung sekunder.
The alternating magnetic fields cut through the secondary coil.
- Arus teraruh dalam gegelung sekunder.
Current is induced in the secondary coil.

(b)

Ciri-ciri ***Characteristic***	**Keterangan** ***Explanation***
Teras besi lembut *Soft iron core*	Untuk mengurangkan kehilangan tenaga melalui histerisis *Reduce the lost of energy through hysteresis*
Teras besi berlamina *Laminated core iron*	Mengurangkan arus pusar yang mengakibatkan pemanasan *Reduce the eddy current that causes the heating*
Injak turun *Step-down*	Manginjak turunkan voltan supaya sesuai kepada telefon bimbit yang memerlukan voltan yang rendah *Step down voltage so that it is suitable for the cellular phone that requires a low voltage*
Wayar kuprum *Copper wire*	Rintangan rendah. *Low resistance*
Q ialah jenis transformer yang paling sesuai digunakan. *Q* mempunyai teras besi lembut dan berlamina, merupakan transformer injak turun, menggunakan wayar kuprum. *Q is the most suitable transformer to be applied. Q has a soft iron and laminated core. It is a step-down transformer, using copper wire*	

(c) (i) Kuprum
copper

(ii) $V = 240\ V - 220\ V = 20\ V$

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

$$= \frac{20}{10}$$

$$= 2\ A$$

(iii) $P = I^2 R$

$$= 2^2 \times 10$$

$$= 40\ W$$

Elektronik
Electronic

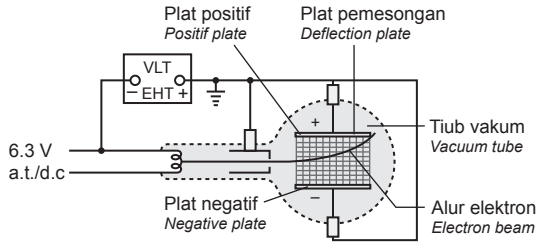
5.1 Elektron
Electron

Pancaran Termion dan Sinar Katod
Thermionic Emission and Cathode Ray

1. katod yang panas, elektron / *hot cathode, electrons*
3. beza keupayaan yang tinggi, alur elektron / *high potential difference, beam of electrons*
4. sinar katod / *cathode rays*

Kesan sinar katod dalam medan elektrik
The effect of cathode rays due to electric field

1.



2. Lintasan sinar katod terpesong ke arah plat positif dalam bentuk parabola. Ini menunjukkan bahawa sinar katod adalah bercas negatif dan tertarik ke plat positif.
The path of cathode ray is in parabola shape attracted towards the positive plat. This indicates that the cathode ray is negatively charged and attracted to the positive plate.

Kesan sinar katod dalam medan magnet
The effect of cathode rays due to magnetic field

4. sinar katod / *cathode rays*
5. katod yang dipanaskan / *a heated cathode*
6. satu bayang gelap, kawasan cahaya hijau / *a dark shadow, a green light region*
7. cahaya, filamen pemanas, dihalang / *the light, heating filament, blocked*
8. menghentam pada skrin berpendarflour, Tenaga kinetik, terpindah, tenaga cahaya / *hits the fluorescene screen, transferred, fluorescence*
9. Dua bayang / *Two shadows*
10. filamen pemanas, medan magnet, bergerak ke bawah / *heating filament, magnetic field, moved down*
11. peraturan Tangan Kiri Fleming / *Fleming Left Hand rule*

- zarah bercas negatif / *negatively charged particles*
- garis lurus / *straight lines*
- tenaga, kerja, pendarfluor / *energy, work, fluorescence*
- medan magnet, medan elektrik / *magnetic fields, electric fields*
- tenaga kinetik, momentum / *kinetic energy, momentum*

Menentukan halaju elektron dalam tiub sinar katod
To determine the speed of electron beam in cathode ray tube

2. $E = eV$
3. tenaga keupayaan elektrik, tenaga kinetik elektron / *electrical potential energy, kinetic energy electron*

$$eV = \frac{1}{2} m_e v^2$$

$$v = \sqrt{\frac{2eV}{2}}$$

yang mana m_e ialah jisim satu elektron dan diberi sebagai 9.1×10^{-31} kg dan v ialah halaju elektron.
where m_e is the mass of an electron and is given as 9.1×10^{-31} kg and v is the velocity of an electron.

Contoh 1

$$v = \sqrt{\frac{2eV}{m_e}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 3000}{9.1 \times 10^{-31}}} = 3.25 \times 10^7 \text{ m s}^{-1}$$

Tugasan 1

1. (a) Pancaran termion ialah pemancaran elektron bebas daripada permukaan logam yang dipanaskan.
Thermionic emission is the emission of free electrons from a heated metal surface.
(b) • Zarah bercas negatif
Negatively charged particles
• Boleh dipesongkan oleh medan magnet dan medan elektrik
Can be deflected by magnetic fields and electric fields.
• Boleh menghasilkan kesan pendarfluor
Can produce fluorescence effect

2. $v = \sqrt{\frac{2eV}{m_e}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 5000}{9.1 \times 10^{-31}}}$
$= 4.2 \times 10^7 \text{ m s}^{-1}$

5.2 Diod Semikonduktor
Semiconductor Diode

Fungsi diod semikonduktor
The function of semiconductor diode

2. terpincang depan, terpincang songsang / *forward bias, reversed bias*
3. mengalir, tidak mengalir / *flows, does not flow*
4. membenarkan, satu arah / *allows, one direction*

Kegunaan diod semikonduktor dan kapasitor dalam rektifikasi arus ulang-alik
The use of semiconductor diode and capacitor in rectification of alternating current

1. rektifier / *rectifier*
2. diod / *diode*

1. arus denyutan, kitaran separuh pertama / *pulsating current, first half-cycle*
2. separuh kitaran pertama, separuh kitaran / *first half cycle, second half cycle*

Pengaliran arus dalam litar rektifikasi gelombang separuh
The flow of current in half-wave rectification circuit

1. rektifier, separuh kitar positif, separuh kitar negatif, arus dihalang / *rectifier, positive half cycle, negative hall cycle, not allowed*

Pengaliran arus dalam litar rektifikasi gelombang penuh
The flow of current in full-wave rectification circuit

2. rektifier, menyongsangkan, kitaran positif, kitaran positif dan negatif, arah yang sama / *bridge rectifier, reverse, positive cycle, positive and negative cycles, same direction*
3. terpincang depan, terpincang songsang, lintasan 1 / *forward bias, reversed bias, path 1*
4. D_2 dan D_4, D_1 dan D_3, lintasan 2 / *D_2 and D_4, D_1 and D_3, path 2*
5. dalam arah yang sama / *in the same direction*
6. lebih rata / *smoother*

Fungsi kapasitor sebagai perata arus dalam litar rektifikasi
The function of capacitor as current smoother in the rectifier circuit

1. kapasitor, selari, meratakan / *capacitor, parallel, smoothen*

Tugasan 2

1. (a) Diod membenarkan arus mengalir dalam satu arah sahaja.
Diodes allow current to flow in one direction only.
(b) (i) Mentol *Q* tidak bernyala kerana ia disambung dalam keadaan pincang songsang.
Bulb Q is not lit up because it is connected in reverse bias.
(i) Terminal *Y* adalah positif. / *Terminal Y is positive.*
(iii) Kedua-dua diod itu digunakan sebagai petunjuk kutub bateri.
Both diodes are used to show the direction of the battery pole.

5.3 Transistor
Transistor

1. menguatkan, memindah / *amplify, switch*
2. semikonduktor jenis-*n*, jenis-*p* / *n-type semiconductors, p-type semiconductors*
3. diod simpang p-n / *p-n junction diodes*
4. tiga terminal, pemancar (E), tapak (B), pengumpul (C), Tapak, pemancar
   three terminals, emitter (E), base (B), collector (C), base, emitter
5. transistor jenis NPN, transistor jenis PNP
   NPN transistor, PNP transistor
6. arah pengaliran arus / *direction of flow current*

Litar transistor npn dan pnp
The npn and pnp transistor circuits

1. litar transistor npn, litar tapak, litar pengeluar / *npn transistor circuit, base circuit, emitter circuit*
2. positif, voltan pengumpul, $+V_C$ / positive, collector voltage, $+V_C$
3. negatif, voltan pengumpul, $-V_C$ / negative, collector voltage, $-V_C$
4. positif, voltan tapak $+V_B$ / positive, base voltage, $+V_B$
5. suis / *switch*
6. 0 V dan 0.7 V / *0 V and 0.7 V*
7. dihidupkan, pengumpul, pemancar, suis / *switched on, collector, emitter, switch*
8. arus yang kecil, mengawal, arus yang lebih besar, penguat / *small current, control, larger current, amplifier*
9. arus tapak, merosakkan, mengehadkan / *base current, damage, limit*
10. transistor pnp, voltan negatif, voltan negatif, $-V_C$, pemancar / pnp transistor, negative voltage, voltage, $-V_C$, emitter

Pembahagi beza keupayaan
Potential divider

2. $V = I(R_1 + R_2)$

$$I = \left(\frac{V}{R_1 + R_2}\right)$$

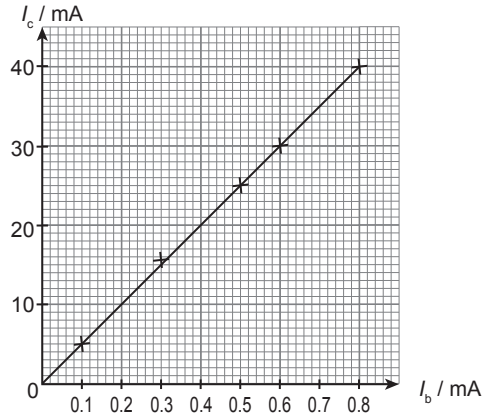
$V_1 = IR_1$ $= \left(\frac{V}{R_1 + R_2}\right) \times R_1$ $= \left(\frac{R_1}{R_1 + R_2}\right)V$	$V_1 = IR_2$ $= \left(\frac{V}{R_1 + R_2}\right) \times R_2$ $= \left(\frac{R_2}{R_1 + R_2}\right)V$

Transistor sebagai penguat arus
Transistor as a current amplifier

Aktiviti 5.6

Keputusan / *Results*:

I_b / mA	0.1	0.3	0.5	0.6	0.8
I_c / mA	5.0	16.0	24.0	30.0	40.0



$$m = \frac{I_c}{I_b}$$
$$= \frac{40}{0.8}$$
$$= 50$$

Maka, faktor penggandaan penguat ialah 50.
Therefore, amplification factor is 50.

Perbincangan / *Discussion*:

1. litar penguat arus / *current amplifier circuit*
2. transistor n-p-n / *npn transistor*
3. perubahan kecil, perubahan besar / *a small change, large change*
4. Gandaan arus, kecerunan graf / *current gain, gradient of graph*

Kesimpulan / *Conclusion*:
penguat arus / *current amplifier*

Litar transistor sebagai suis automatik ***Transistor as an automatic switch***	
Litar ***Circuit***	**Aktiviti dan pemerhatian** ***Activity and observation***
Dalam keadaan gelap, PPC mempunyai rintangan sangat tinggi (1 MΩ). *In dark conditions , PPC has a very high resistance* (1 MΩ). Dalam keadaan cerah, PPC mempunyai rintangan sangat rendah (beberapa ratus Ohm). *In bright conditions, PPC has very low resistance (several hundred Ohms).*	Suis dihidupkan dan PPC ditutup dengan kertas hitam . *Switch is turned on and LDR is covered with black paper .* Lampu LED bernyala . *The LED lights up .* Kertas hitam dialihkan supaya PPC terdedah kepada cahaya. *The black paper is removed so that LDR is exposed to light.* Lampu LED tidak bernyala. *The LED does not light up .*

PPC dan perintang 10 kΩ saling bertukar tempat . *The LDR and resistance 10 kΩ exchange places.*	Suis dihidupkan dan PPC ditutup dengan kertas hitam. *Switch is turned on and LDR is covered with black paper* Lampu LED tidak bernyala. *The LED does not light up.* Kertas hitam dialihkan supaya PPC terdedah kepada cahaya. *The black paper is removed so that LDR is exposed to light.* Lampu LED bernyala. *The LED lights up.*

Situasi 1 / *Situation 1*

Keadaan cerah ***Bright condition***	**Keadaan gelap** ***Dark condition***
Rintangan PPC: Sangat rendah *LDR Resistance:* *Very low* Voltan tapak: Sangat rendah *Base voltage:* *Very low* Arus tapak: Terlalu kecil untuk menghidupkan transistor. *Base current:* *Too small to activate the transistor*	Rintangan PPC: Sangat tinggi *LDR resistance:* *Very high* Voltan tapak: Tinggi *Base voltage:* *High* Arus tapak: Cukup tinggi untuk menghidupkan transistor. *Base current:* *High enough to activate the transistor.*
Arus pengumpul tidak mengalir dan LED tidak bernyala *No collector current and LED is not light up.*	Arus pengumpul mengalir dan LED bernyala. *Collector current is flowing and LED lights up.*
Kesimpulan / Conclusion: LED akan bernyala dalam keadaan gelap dan dimatikan dalam keadaan cerah. *The LED lights up in the dark and turn off in bright condition.*	

Situasi 2 / *Situation 2*

Keadaan cerah ***Bright condition***	**Keadaan gelap** ***Dark condition***
Rintangan PPC: Sangat rendah *LDR Resistance:* *Very low* Voltan tapak: Tinggi *Base voltage:* *High* Arus tapak: Cukup tinggi untuk menghidupkan transistor. *Base current:* *High enough to activate the transistor.*	Rintangn PPC: Sangat tinggi *LDR resistance:* *Very high* Voltan tapak: Sangat rendah *Base voltage:* *Very low* Arus tapak: Terlalu kecil untuk menghidupkan transistor. *Base current:* *Too small to activate the transistor*
Arus pengumpul mengalir dan LED bernyala . *Collector current is flowing and LED lights up.*	Arus pengumpul tidak mengalir dan LED tidak bernyala. *No collector current and LED is not light up .*
Kesimpulan / Conclusion: LED akan bernyala dalam keadaan cerah dan dimatikan dalam keadaan gelap. *The LED lights up in bright condition and turn off in the dark .*	

Transistor sebagai suis kawalan haba atau suhu
Transistor as heat or temperature controlled switch

Litar ***Circuit***	**Fungsi litar dan penjelasan** ***Circuit function and explaination***
Termistor ialah perintang peka haba atau suhu. *Thermistor is a heat or temperature-sensitive resistor.* Ada dua jenis */ There are two types*: • Jenis PTC (Pekali suhu positif) / *PTC (Positive temperature coefficient):* Rintangan meningkat dengan kenaikan suhu . *Whose resistance increases with increasing temperature .* • Jenis NTC (Pekali suhu Negatif) / *NTC (Negative Temperature Coefficient):* Rintangan berkurang dengan kenaikan suhu . *Resistance decreases with increasing temperature .* Suis automatik kawalan haba ini adalah sesuai untuk digunakan dalam sistem penggera kebakaran kebakaran. *This automatic heat control switch is suitable for a fire alarm system.*	Katakan termistor yang digunakan ialah jenis NTC yang mana rintangannya berkurang apabila suhunya meningkat. *Suppose the thermistor used is NTC type whose resistance decreases with increasing temperature.* **1.** Pada suhu bilik, termistor mempunyai rintangan yang tinggi berbanding dengan perintang *R*. Maka, beza keupayaan merentasi tapak transistor adalah terlalu rendah dan tidak cukup untuk menghidupkan transistor. *At room temperature, the thermistor has a high resistance compared to resistor R. Therefore, the potential difference across the base of the transistor is too low and not enough to activate the transistor.* **2.** Apabila suhu meningkat, rintangan termistor berkurang dengan banyak berbanding dengan rintangan *R*. Maka, beza keupayaan merentasi *R* bertambah dan voltan tapak bertambah. Transistor diaktifkan dan arus pengumpul mengalir menghidupkan geganti dan lalu mengaktifkan penggera. *As the temperature increases, the resistance of the thermistor decreases significantly compared to the resistance of R. Thus, the potential difference across R increases . The base voltage increases and is large enough to activate the transistor. The collector current flows and on the relay and then activates the alarm.*

Tugasan 2

1. (a) Pengeluar / *Emitter*

(b) Transistor jenis pnp / *PNP transistor*

2. (a) Termistor / *Thermistor*

(b) Fungsi *P* ialah untuk mengesan perubahan suhu. Rintangan *P* berkurang dengan kenaikan suhu.
The function of P is to detect the changes in temperature. Resistance of P decreases with increasing temperature

(c) (i) 9 V

(ii) $V_{XY} = \left(\frac{6}{6 + 10}\right) \times 9 = 3.375$ V

PRAKTIS SPM 5

Soalan Objektif

1. D **2.** B **3.** C **4.** A **5.** B

Soalan Struktur

Bahagian A

1. (a) (i) Komponen *S* ialah diod dan *T* ialah kapasitor.
Component S is a diode, and T is a capacitor.

(ii) Kapasitor dicaskan apabila voltan output bertambah dan dinyahcaskan apabila voltan output berkurangan. Arus nyahcas dari kapasitor mengekalkan voltan output yang seragam merentasi perintang, *R*.
The capacitor is charged when the output voltage increases and discharged when the output voltage decreases. The discharge current from the capacitor maintains a steady output voltage across the resistor R.

(b) (i) $V_{XY} = \frac{40}{40 + 10} \times 12$ V = 9.6 V

$V_{YZ} = \frac{10}{40 + 10} \times 12$ V = 2.4 V

(ii) Jumlah rintangan / *Total resistance*,
R = 40 kΩ + 10 kΩ = 50 kΩ

Arus / *Current*, $I = \frac{V}{R} = \frac{12}{50 \times 10^3}$

$= 2.4 \times 10^{-4}$ A

Bahagian B

2. (a) (i) Transistor npn / *npn transistor*

(ii)
- Kedua-dua ammeter tidak menunjukkan bacaan
Both ammeters do not show any reading
- Mikroammeter menunjukkan satu bacaan, manakala miliammeter tidak menunjukkan bacaan.
Microammeter shows a reading, while miliammeter does not show any reading.

(b) Apabila reostat dilaraskan dan kedua-dua suis dihidupkan, suatu arus tapak dihasilkan untuk mengaktifkan transistor. Ini menyebabkan suatu arus pengumpul yang lebih besar mengalir dalam litar.
When the rheostat is adjusted and both switched are on, a base current is produced to activate the transistor. This causes a large collector current flows in the circuit.

(c) $\beta = \frac{I_c}{I_b} \times \frac{1 \times 10^{-3}}{10 \times 10^{-6}} = 100$

$I_c = I_b + I_e$
$I_e = I_c - I_b$
$= 1 \times 10^{-3} - 10 \times 10^{-6}$
$= 9.9 \times 10^{-4}$ A

(d)
- Untuk mengesan kebakaran, termistor digunakan untuk mengesan haba dan perlu disambung ke terminal *P* sebagai pembahagi beza keupayaan.
To detect fire, the thermistor is used to detect heat and should be connected to terminal P as potential divider.
- Satu perintang perlu disambung kepada terminal *Q* untuk mengawal saiz arus yang mengalir ke dalam tapak transistor.
A resistor should be connected to terminal Q to control the size of current that flow in transistor base.
- Pada terminal pengumpul transistor, iaitu terminal *R*, harus dipasang dengan penggera untuk memberi amaran kepada orang ramai apabila diaktifkan.
At collector transistor terminal, which is terminal R, should build with alarm to warn people once it has activated
- Oleh kerana transistor yang digunakan dalam litar ialah jenis npn, sel kering digunakan dan dipasang kepada terminal *S*. Terminal positif di atas dan terminal negatif di bawah.
Because the type of transistor used in the circuit is npn type, dry cell is used and built into terminal S. Positive terminal is above and negative terminal is below it.
- Set yang paling sesuai ialah set *X*. Set *X* menggunakan termistor sebagai pengesan, perintang untuk mengawal arus tapak transistor, penggera untuk memberi amaran semasa kebakaran berlaku dan sel kering memberikan sambungan yang betul dengan transistor npn.
The suitable set is Set X. Set X used a thermistor as detector, a resistor to control transistor base current, an alarm to warn during fire, and dry cell to give the correct connection with transistor npn.

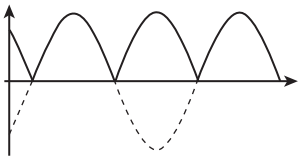
Bahagian C

3. (a) Membenarkan arus mengalir dalam satu arah.
Allow current to flow in one direction.

(b)
- Mentol dalam Rajah 3.1 (b) menyala tetapi mentol dalam Rajah 3.1 (a) tidak menyala.
The bulb in Diagram 3.1 (b) lights up but the bulb in Diagram 3.1(a) doesn't light up.
- Arus elektrik mengalir dalam Rajah 3.1 (b) tetapi tidak mengalir dalam Rajah 3.1 (a).
Electric current flows in Diagram (b) but doesn't flow in Diagram (a)
- Diod dalam Rajah 3.1 (a) dipasang secara pincang songsang manakala diod dalam Rajah 3.1 (b) dipasang secara pincang hadapan.
The diode in Diagram (a) is in reverse-biased whereas the diode in Diagram (b) is in forward-biased.
- Mentol bernyala apabila diod disambungkan secara pincang hadapan. Mentol tidak bernyala apabila diod disambungkan secara pincang songsang.
The bulb lights up when the diode is in forward-biased whereas the bulb doesn't light up when the diode is in reverse-biased.
- Arus elektrik mengalir jika diod disambungkan secara pincang hadapan. Arus elektrik tidak mengalir jika diod disambungkan secara pincang songsang.

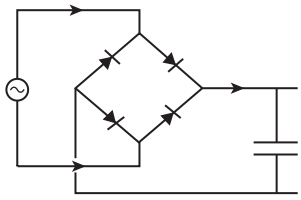
Electric current is flowing when the diode is in forward-biased.
Electric current is not flowing when the diode is in reverse-biased.

(c) (i)

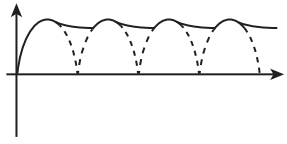


(ii) Kapasitor / *Capacitor*

(iii)



(iv)



(d)

Ciri-ciri *Characteristic*	Keterangan *Explanation*
Termistor digunakan. *A thermistor is applied.*	Nilai rintangan termistor berubah dengan perubahan suhu persekitaran. *The resistance of the thermistor changes with the change in surroundings temperature.*
Termistor itu diletakkan pada kedudukan R_1 dan R_1 menggantikan tempat PPC. *The thermistor is placed at the position of R_1 and R_1 replaces the position of the LDR.*	Beza keupayaan merentasi R_1 meningkat apabila suhu persekitaran meningkat. Arus tapak yang mengalir menghidupkan transistor itu menghidupkan transistor. *Potential difference across R_1 increases when the surroundings temperature increases. The base current that flows through the transistor switches on the transistor.*
Suis geganti digunakan. *A relay switch is applied.*	Suis geganti mengasingkan litar kawalan bertransistor daripada litar penghawa dingin yang berkuasa tinggi (lebih bahaya). *The relay switch separates the transistor control circuit form the air conditioner circuit that has a high power (more dangerous).*
Penghawa dingin disambungkan kepada suis geganti. *The air conditioner is connected to the relay switch.*	Litar penghawa dingin yang berkuasa tinggi boleh dihidupkan oleh litar kawalan bertransistor yang berkuasa rendah. *The air conditioner circuit in high power can be switched on by the transistor control circuit that is in low power.*
Perintang disambungkan pada tapak transistor. *The resistor is connected to the base of the transistor.*	Mengehadkan nilai arus yang mengalir melalui transistor. *Limits the value of current that flows through the transistor.*

BAB 6

Fizik Nulear
Nuclear Physics

6.1 Reputan Radioaktif
Radioactive Decay

1. stabil, sinaran radioaktif / *stable, radioactive radiation*

2. nukleas induk, nukleas anak / *parent nucleus, daughter nucleus*

Reputan alfa
Alpha decay

3. berat, tidak stabil / *heavier, unstable*

4. ${}^{234}_{90}Th + {}^{4}_{2}He$

5. nombor proton, nombor nukleon / *proton number, nucleon number*

6. ${}^{A-4}_{Z-2}Th + {}^{4}_{2}He$

Reputan beta
Beta decay

7. lebihan / *excess*

8. ${}^{14}_{7}N + {}^{0}_{-1}e$

9. ${}^{1}_{1}p + {}^{0}_{-1}e$

10. nombor proton, nombor nukleon / *proton number, nucleon number*

Reputan gama
Gamma decay

11. tak stabil, gelombang elektromagnet / *unstable, electromagnetic waves*

13. nombor proton, nombor nukleon / *proton number, nucleon number*

Siri reputan sumber radioaktif
Radioactive decay series

1. masa yang diambil, setengah, nilai asalnya / *time taken, half, initial number*

2. reputan radioaktif, stabil / *radioactive decay, stable*

3. nukleus anak, satu nuklid yang stabil / *daughter nucleus, a stable nuclide*

4. 8, 6

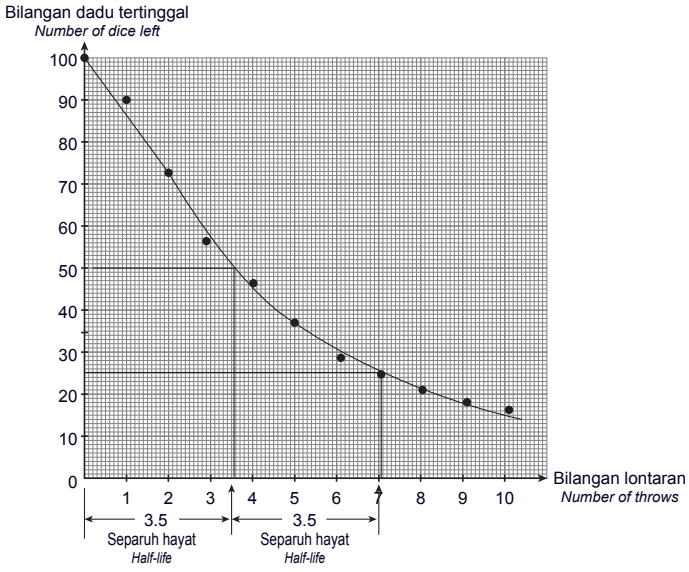
5. siri reputan uranium / *decay series of uranium*

6. mengukur kadar, nisbah uranium, plumbum / *age of rock, measuring the rate, ratio of uranium, lead*

Menentukan separuh hayat bahan sumber radioaktif
Determine the half-life of radioactive source

Aktiviti 6.1

Keputusan / *Results*:



Perbincangan / *Discussion*:

1. melontar 100 dadu ke dalam kotak / *throwing 100 dice in the box*
   nukleus beradioaktif / *radioactive nuclei*
   nukleus yang telah 'reput' / *nuclei which have 'decayed'*
2. reputan radioaktif / *decay curve*
3. jumlah dadu yang dilemparkan / *the number of dice thrown*
4. 3½ lontaran, 100 hingga 50, lontaran 3½, 50 hingga 25, 3½ lontaran, 'mereput', separuh hayat / *3½ throws, 100 to 50, 3½ throws, 50 to 25, 3½ throws, 'decay', half-life*

Menentukan separuh hayat bahan sumber radioaktif daripada lengkung reputan
To determine the half-life of a radioactive source from decay curve

3. N_0 = bilangan asal nukleus / *original number of nucleus*
   n = bilangan separuh hayat / *number of half-life*
   $T_{\frac{1}{2}}$ = separuh hayat bahan sumber radioaktif
   half-life of radioactive source

Menyelesaian masalah yang melibatkan separuh hayat
Solving problems involving half-life

Contoh 1

(a) Masa untuk bilangan nukleus yang aktif jatuh dari 240 000 ke 120 000 ialah 55 s
Time for the number of active nuclei to fall from 240 000 to 120 000 is 55 s

Masa untuk bilangan nukleus yang aktif jatuh dari 120 000 ke 60 000 ialah 55 s
Time for number of active nuclei fall from 120 000 to 60 000 is 55 s

Maka, separuh hayat = 55 s
Therefore, half-life = 55 s

(b) $n = \frac{220}{55} = 4$

$$N = \left(\frac{1}{2}\right)^n N_0$$
$$= \left(\frac{1}{2}\right)^4 \times 270\,000$$
$$= 16875$$

Bilangan nukleus yang sudah reput
Number of decayed nuclei
= 270 000 – 16875
= 253 125

Maka, nisbah / *Therefore, ratio* $= \frac{16875}{253125} = \frac{1}{2}$

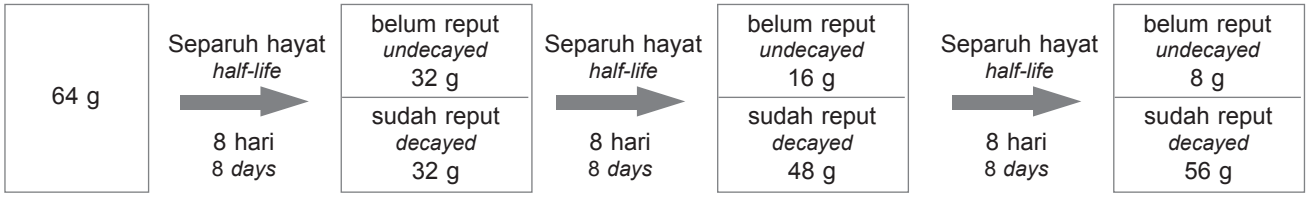
Contoh 2

N_0 = 64 g

$n = \frac{24}{8} = 3$

$$N = \left(\frac{1}{2}\right)^n N_0$$
$$= \left(\frac{1}{2}\right)^3 \times 64\text{ g}$$
$$= 8\text{ g}$$

Jisim iodin sudah reput / *Mass of decayed iodine* = 64 g – 8 g = 56 g



Tugasan 1

1. (a) $^{214}_{83}Bi$ (b) $^{222}_{86}Rn$

(c) $^{234}_{91}Pa$ (d) $^{239}_{93}Cp$

(e) $^{227}_{89}Ac$

2. $^{214}_{83}Bi \xrightarrow{\beta, \gamma} {}^{214}_{84}Po \xrightarrow{\alpha} {}^{210}_{82}Pb \xrightarrow{\beta, \gamma}$

$^{210}_{83}Bi \xrightarrow{\beta} {}^{214}_{84}Bi \xrightarrow{\alpha, \gamma} {}^{206}_{82}Pb$

3. (a) $N \xrightarrow[20\ \text{min}]{} \frac{1}{2}N \xrightarrow[20\ \text{min}]{} \frac{1}{4}N \xrightarrow[20\ \text{min}]{} \frac{1}{8}N$

Maka, 3 separuh hayat
Therefore, 3 half-lives

(b) $\frac{1}{8}$ daripada sampel tidak mereput
$\frac{1}{8}$ *of the original sample undecayed*

6.2 Tenaga Nuklear
Nuclear Energy

1. tindak balas nuklear, pembelahan nukleus, pelakuran nukleus / *nuclear reactions, nuclear fission, nuclear fusion*

Pembelahan Nukleus
Nuclear Fission

1. terbelah, dua nukleus yang lebih ringan, membebaskan / *splits, two lighter nuclei, releases*

Pelakuran nukleus
Nuclear fusion

1. gabungan / *combining*
4. matahari / *sun*

Perbandingan antara pembelahan nuklear dan pelakuran nuklear
Comparison between nuclear fission and nuclear fusion

1. tidak berlaku / *does not occur*
2. lebih ringan / *lighter*
3. tinggi / *high*
4. sisa nuklear / *nuclear waste*
6. Tenaga / *energy*
7. jisim / *Mass*
8. matahari / *sun*
9. lebih berat / *heavier*
10. tinggi / *high*
11. sisa nuklear / *nuclear waste*

Tenaga dalam tindak balas nuklear
Energy in a nuclear reaction

1. E = Tenaga nuklear dibebaskan / *Nuclear energy released* (J)
m = Kecacatan jisim / *Mass defect* (kg)
c = Kelajuan cahaya / *speed of light* (3.0×10^8 m s^{-1})
2. unit jisim atom (u.j.a.) / *atomic mass unit (amu)*

3. 12 u.j.a, $\frac{1}{12}$ / *12 a.m.u,* $\frac{1}{12}$

Maka, jisim 1 karbon atom / *Therefore, mass of 1 carbon atom*
$= \frac{12\ \text{g}}{6.02 \times 10^{23}} = 1.99 \times 10^{-23}$ g

1 u.j.a. / *a.m.u* $= \frac{1}{12} \times 1.99 \times 10^{-23\ \text{g}}$
$= 1.66 \times 10^{-24}$ g $= 1.66 \times 10^{-27}$ kg
Dalam unit SI, 1 u.j.a. / *In SI unit,* 1 a.m.u. $= 1.66 \times 10^{-27}$ kg.

Menyelesaikan masalah yang melibatkan tenaga nuklear
Solving problems involving nuclear energy

Contoh 1

Jisim cacat / *Mass defect*, Δm
= 226.025406 u – 222.017574 u – 4.002603 u
= 0.005229 u
= $0.005229 \times 1.66 \times 10^{-27}$ kg
= 8.68×10^{-30} kg

Maka, tenaga yang dibebaskan,
Therefore, the energy released,
$E = \Delta mc^2$
$= 8.68 \times 10^{-30} \times (3.00 \times 10^8)^2$
$= 7.81 \times 10^{-13}$ J

Contoh 2

Jumlah jisim sebelum tindak balas berlaku / *Total mass before the reaction*
= 1.008665 u + 235.043923 u
= 236.052588 u

Jumlah jisim selepas tindak balas berlaku / *Total mass after the reaction*
= 143.922941 u + 89.919529 u + 2 × 1.008665 u
= 235.8598 u

Jisim cacat / *mass defec,* Δm
= 236.052588 u – 235.8598 u
= 0.192788 u
= 0.192788 × 1.66 × 10–27 kg
= 3.20×10^{-28} kg

Tenaga yang dibebaskan / *Energy released,*
$E = \Delta mc^2$
$= 3.20 \times 10^{-28} \times (3.00 \times 10^8)^2$
$= 2.88 \times 10^{-11}$ J

Contoh 3

Cacat jisim / *Mass defect*, Δm
= 2.014102 u + 2.014102 u – 3.016049 u – 1.007825 u
= 0.004330 u
= $0.004330 \times 1.66 \times 10^{-27}$ kg
= 7.19×10^{-30} kg

Maka, tenaga yang dibebaskan,
Therefore, energy released,
$E = \Delta mc^2$
$= 7.19 \times 10^{-30} \times (3.00 \times 10^8)^2$
$= 6.47 \times 10^{-13}$ J

Penjanaan tenaga elektrik dalam reaktor nuklear
Generation of electrical energy in a nuclear reactor

1. pembelahan nukleus / *nuclear fission*
2. tindak balas berantai / *chain reaction*
3. terkawal, dibebaskan / *controlled, released*
4. (a) neutron berlebihan / *excess neutrons*
   (b) memperlahankan / *slow down*
   (c) tenaga haba / *heat energy*
   (d) menghalang kebocoran / *prevents leakage*

Penggunaan tenaga nuklear sebagai tenaga alternatif untuk menjana tenaga elektrik
The use of nuclear energy as an alternative to generate electricity

Membandingkan penjanaan tenaga elektrik dari loji kuasa yang menggunakan arang batu, tenaga hidro dan tenaga nuklear.
Compare power generation from coal-fired power plants, hydroelectric and nuclear power plants.

Jenis loji kuasa / *Types of power plant* — Aspek / *Aspect*	Arang batu / *Coal*	Tenaga hidro / *Hydropower*	Tenaga nuklear / *Nuclear energy*
Kos (pembinaan, operasi dan pengyelenggaran) *Cost (construction, operation and maintenance)*	Kos pembinaan tidak tinggi, tetapi kos operasi dan penyelenggaraannya tinggi. *Construction costs are not high, but operation and maintenance costs are high.*	Projek berskala besar dan kos pembinaan tinggi. Kos operasi dan penyelenggaraan adalahsederhana. *Big scale and high construction cost. The operation and maintenance costs are average.*	Kos pembinaan tinggi, tetapi kos operasi dan penyelenggaraan rendah. *High construction cost, but low operating and maintenance costs.*
Lokasi loji kuasa *Location of power plant*	Terletak berhampiran lombong arang batu atau pantai. *Located near coal mines or coastal prefectures.*	Harus dibina di sepanjang lintasan sungai. *Should be built along the path of a river.*	Hendaklah dibina berhampiran kawasan tepi sungai atau pantai. *Should be built near riverside or coastal prefectures.*
Kesan kepada ekosistem dan jejak karbon *Impact on ecosystems and carbon footprint*	Boleh menyebabkan pencemaran udara dan kesan pada jejak karbon tinggi. *Can cause air pollution and the impact on carbon footprint is high.*	Kesan terhadap ekosistem tinggi semasa pembinaan. Kurang kesan pada jejak karbon. *The impact on ecosystems is high during construction. Less impact on carbon footprint.*	Sistem penyejukan boleh mempengaruhi ekosistem yang berdekatan. Kurang kesan pada jejak karbon. *The cooling system can affect the ecosystem nearby. Less impact on carbon footprint.*
Isu keselamatan dan kesihatan *Safety and health issues*	Mengeluarkan gas berbahaya ke dalam atmosfera. Tidak mesra alam. *Emit harmful gases into the atmosphere. Not environmentally friendly.*	Mengeluarkan sedikit gas rumah hijau. Dianggap mesra alam. *Emit fewer greenhouse gases. Consider environmentally friendly.*	Tidak mengeluarkan gas rumah hijau. Kemalangan boleh membebaskan bahan radioaktif yang bahaya. *Do not emit greenhouse gases. Accidents could emit dangerous radioactive materials.*
Teknologi dan kepakaran *Technology and expertise*	Tidak memerlukankepakaran teknologi tinggi untuk penyelenggaraan. *Do not require high technological expertise for maintenance.*	Tidak memerlukan kepakaran teknologi tinggi untuk penyelenggaraan. *Do not require high technological expertise for maintenance.*	Memerlukan kepakaran teknologi untuk penyelenggaran. *Require high technological expertise for maintenance.*
Isu pengurusan sisa *Issues of waste management*	Masalah pengurusan sisa adalah tinggi. *Waste management issues are high.*	Masalah pengurusan sisa kurang. *Less issue of waste management.*	Tiada penyelesaian yang baik untuk pembuangan sisa nuklear. *No good solution to disposal of nuclear waste.*

Tugasan 2

1. (a) Pembelahan nuclear / *Nuclear fission*
   (b) (i) Cacat jisim / *Mass defect*
   = 1.008 665 u + 235.043 923 u – 137.911017 u – 95.934 273 u – 2 × 1.008 665 u
   = 0.189968 × 1.66 × 10^{-27} kg
   = 3.15 × 10^{-28} kg
   (ii) $E = mc^2$
   = 3.15 × 10^{-28} × (3.00 × 10^{8})^2
   = 2.835 × 10^{-11} J
2. I : Rod kawalan / *Control rod*
   II : Teras / *Core*
   III : Rod uranium / *Uranium rod*
   (a) Pembelahan nukleus / *Nuclear fission*

(b) Moderator dalam reaktor digunakan untuk melambatkan pergerakan neutron.
The moderator in the reactor is used to slow down motion of neutrons.

PRAKTIS SPM 6

Soalan Objektif

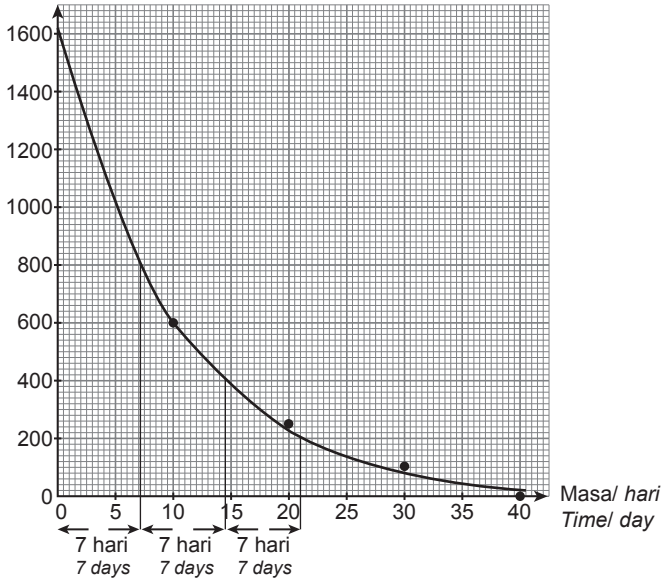
1. B **2.** C **3.** B **4.** A **5.** A **6.** B

Soalan Struktur

Bahagian A

1. (a) 4 unit, 2 unit / *4 units, 2 units*
(b) (i)

Keradioaktifan/ bilangan per minit
Radioactivity/ count per minute



(ii) Separuh hayat / *Half-life* = 7 hari / *days*
(iii) Untuk aktiviti turun sehingga 50 bilangan seminit
For activity to drop to / 50 counts per minute:
Ini melibatkan 5 separuh hayat, maka masa ketika susu menjadi selamat untuk diminum ialah
= 5 × 7 hari = 35 hari.
This involves 5 half-life, and then the time when the milk is safe to drink is = 5 × 7 days = 35 days.

2. (a) (i) Suatu proses nukleus tidak stabil menjadi lebih stabil dengan memancarkan sinaran radioaktif.
A process in which an unstable nucleus becomes more stable by emitting radioactive radiation.
(ii) Pembelahan nuklear adalah proses di mana satu nukleus besar terbelah menjadi dua nukleus yang lebih kecil dengan pembebasan tenaga.
Nuclear fission is the process in which a large nucleus splits into two smaller nuclei with the release of energy.
(b) (i) Pembelahan nuklear / *Nuclear fission*
(ii) A : 92 Z : 36
(c) (i) Cacat jisim / *Mass defect* = $0.18606 \times 1.66 \times 10^{-27}$ kg = 3.09×10^{-28} kg
(ii) $E = mc^2 = 3.09 \times 10^{-28} \times (3.0 \times 10^8)^2$
$= 2.78 \times 10^{-11}$ J

BAB 7 Fizik Kuantum
Quantum Physics

7.1 Teori Kuantum Cahaya
Quantum Theory of Light

1. (i) Sinar gama / *Gamma rays*
(ii) Sinar-X / *X-ray*
(iii) Sinaran ultraungu / *Ultraviolet rays*
(iv) Visible light / *Cahaya nampak*
(v) Sinaran inframerah / *Infrared rays*
(vi) Gelombang mikro / *Microwaves*
(vii) Gelombang radio / *Radio waves*
2. sinaran elektromagnet / *electromagnetic ray*
3. rendah, tinggi / *low, high*

Perkembangan teori kuantum dari teori klasik
The development of quantum theory from classical theory

1. (a) garisan lurus, pantulan cahaya, pembiasan cahaya / *straight-line, reflection, refraction*
(b) corak interferens, pembelauan, gelombang / *interference patterns, diffraction, waves*
(c) secara berterusan, paket, quanta, foton / *continuously, packets, quanta, photon*
(d) model gelombang, konsep foton, $E = hf$ / *wave model, photon concept, E = hf*
(e) • ciri zarah / *Particle nature*
• ciri gelombang / *Wave nature*

Ciri pancaran jasad hitam
Black body radiation characteristics

1. menyerap semua sinaran elektromagnet, tuju, memancarkan pada semua frekuensi / *absorbs all electromagnetic radiation, falls, emits at all frequencies*
2. sinaran termal / *thermal radiation*
3. spektrum selanjar / *continuous spectrum form*
4. sinaran elektromagnet / *electromagnetic radiation*

6. (i) Bintang biru / *Blue star*
(ii) Bintang putih seperti Matahari / *White star likes the Sun*
(iii) Bintang merah / *Red star*

Maksud kuantum tenaga
The meaning of quantum energy

1. paket tenaga dipanggil kuantum, diskrit, terkecil / *a packet of energy called quantum, discrete, smallest*
2. tenaga cahaya, berkadar terus / *light energies, directly proportional*

Sifat kedualan gelombang-zarah
Properties of wave-particle duality

1. panjang gelombang dan frekuensi, kedualan gelombang-zarah / *wavelength and frequency, wave-particle duality*
2. sifat gelombang, sifat zarah / *wave properties, particle properties*
3. (a) p = momentum
h = pemalar Planck / *Planck's constant*
λ = panjang gelombang de Broglie / *de Broglie wavelength*
(b) $p = mv$ / $\frac{h}{mv}$
4. • $E = hf$

Contoh 1

(a) Ganti / *Substitute* $h = 6.63 \times 10^{-34}$ J s
dan frekunsi / *and frequency* $f = 4.05 \times 0^{14}$ Hz
ke dalam / *into* $E = hf$
Tenaga foton cahaya hijau / *Energy of green light photon,*
$E = 6.63 \times 10^{-34} \times 4.05 \times 10^{14}$ J
$= 2.69 \times 10^{-19}$ J

(b) $\lambda = 700$ nm $= 700 \times 10^{-9}$ m
Tenaga foton cahaya merah / *The energy of red-light photon*,

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{700 \times 10^{-9}}$$
$$= 2.84 \times 10^{-19} \text{ J}$$

Contoh 2

(a) Ganti / *Substitute* $E = 3 \times 10^{-12}$ J dalam / *in*

$$\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3 \times 10^{-12}}$$
$$= 6.63 \times 10^{-14} \text{ m}$$

(b) Gantian / *Substitute* $P = 1.0$ mW $= 1.0 \times 10^{-3}$ W
dan / *and* $\lambda = 540 \times 10^{-9}$ m
dalam / *in* $P = n\frac{hc}{\lambda}$

$$1.0 \times 10^{-3} = n \times \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{540 \times 10^{-9}}$$
$$1.0 \times 10^{-3} = n \times 3.68 \times 10^{-19}$$

Maka / *Therefore*, $n = 2.74 \times 10^{15}$ foton per saat / *photon per second*

Tugasan 1

1. Gunakan / *Using* $p = mv$; $p = \frac{h}{\lambda}$ => $mv = \frac{h}{\lambda}$

$$v = \frac{h}{m\lambda} = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-34} \times 1 \times 10^{-10}} = 7.29 \times 10^{6} \text{ m s}^{-1}$$

2. (a) $E = hf = 6.63 \times 10^{-34}$ J s $\times 4.72 \times 10^{14}$ s^{-1} $= 3.13 \times 10^{-19}$ J

$$E = \frac{hc}{\lambda} \quad \lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3.13 \times 10^{-19}}$$
$$= 6.35 \times 10^{-7} \text{ m}$$

Alternatif / *Alternative*: $\lambda = \frac{c}{f} = \frac{3.0 \times 10^{8}}{4.72 \times 10^{14}}$
$= 6.5 \times 10^{-7}$ m

(b) Frekuensi / *frequency* $f = \frac{c}{\lambda} = \frac{3.0 \times 10^{8}}{560 \times 10^{-9}}$
$= 5.35 \times 10^{14}$ Hz

Tenaga / *Energy*, $E = hf$
$= 6.63 \times 10^{-34} \times 5.35 \times 10^{14}$ Hz
$= 3.54 \times 10^{-19}$ J

3. (a) $E = \frac{nhc}{\lambda} \rightarrow n = \frac{E\lambda}{hc} = \frac{2.0 \times 10^{3} \times 456 \times 10^{-9}}{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}$
$= 4.68 \times 10^{21}$

(b) $E = \frac{nhc}{\lambda} = \frac{1.0 \times 10^{14} \times 6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{1.0 \times 10^{-12}}$
$= 19.9$ J

4. Tenaga / *Energy*, $E = nhf$
$Pt = nhf$

$$n = \frac{Pt}{hf} = \frac{18 \times 1}{6.63 \times 10^{-34} \times 6.5 \times 10^{14}}$$
$= 4.18 \times 10^{19}$ foton per saat / *photon per second*

5. (a) Momentum zarah, $p = \frac{h}{\lambda} = \frac{6.63 \times 10^{-34}}{560 \times 10^{-9}}$
$= 1.18 \times 10^{-27}$ kg m s^{-1}

(b) Tenaga setiap foton / *Energy of each photon,*
$E = hf = \frac{hc}{\lambda} = pc$
$= 1.18 \times 10^{-27}$ kg m s^{-1} $\times 3.0 \times 10^{8}$ m s^{-1}
$= 3.54 \times 10^{-19}$ J

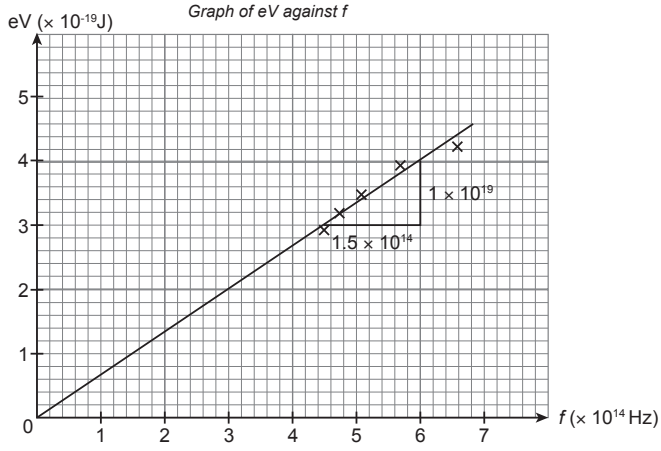
7.2 Kesan Fotoelektrik
Photoelectric Effect

1. (a) Kesan fotoelektrik / *Photoelectric effect.*
(b)

Panjang gelombang LED ***LED wavelength*** λ	**Frekuensi foton** ***Frequency of photon / Hz*** $f = \frac{c}{\lambda} = \frac{3 \times 108}{\lambda}$	**Voltan mula menyalakan** ***LED Voltage to lid up LED / V***	**Tenaga foton dikeluarkan** ***Energy of emitted photon*** $E = eV$ **1 eV = 1.6 × 10^{-19} J**
465 nm	6.45×10^{14}	2.60	4.16×10^{-19}
560 nm	5.66×10^{14}	2.44	3.90×10^{-19}
585 nm	5.13×10^{14}	2.22	3.55×10^{-19}
635 nm	4.72×10^{14}	2.01	3.20×10^{-19}
660 nm	4.55×10^{14}	1.85	2.96×10^{-19}

(ii)

Graf eV melawan f
Graph of eV against f



(iii) Pemalar Planck / *Planck's constant*
= kecerunan graf / *gradient of the graph*

$$= \frac{1 \times 10^{-19}}{1.5 \times 10^{14}}$$

$$= 6.67 \times 10^{-34} \text{ J s}$$

2.
- tinggi / *greater*
- lebih besar / *greater*
- tidak / *does not*
- serta merta / *instantaneous*

Ingat / *Remember*:
- tidak bergantung, keamatan / *independent, intensity*
- bilangan elektron, frekuensi, tenaga kinetik / *number of, electrons, frequency, kinetic energy*
- pengeluaran elektron / *ejection of electrons*
- tenaga kinetik, lebih besar / *kinetic energies, greater*
- tenaga, keamatan / *energy, intensity*

Tugasan 2

1. (a) Apabila cahaya berfrekuensi yang sesuai dipancar pada permukaan logam, elektron dikeluarkan dari permukaan logam. Fenomena ini dipanggil kesan fotoelektrik.
When light with a suitable frequency is incident on a metal surface, electrons are emitted from the metal surface. This phenomenon is called the photoelectric effect.

(b) Teori gelombang meramalkan bahawa kesan fotoelektrik harus berlaku pada sebarang frekuensi, dengan syarat keamatan cahaya adalah cukup tinggi. Walau bagaimanapun. Seperti yang dilihat dalam eksperimen fotoelektrik, cahaya harus mempunyai frekuensi yang cukup tinggi (lebih besar daripada frekuensi ambang) agar kesan itu berlaku.
Wave theory predicts that the photoelectric effect should occur at any frequency, provided the light intensity is high enough. However. As seen in the photoelectric experiments, the light must have a sufficiently high frequency (greater than the threshold frequency) for the effect to occur.

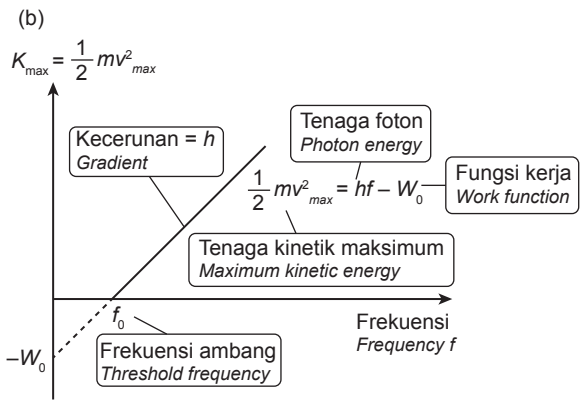
2. Keamatan cahaya tuju mempengaruhi bilangan elektron yang dipancarkan, dan frekuensi mempengaruhi tenaga kinetik maksimum elektron yang dipancarkan. Oleh itu, kelajuan maksimum elektron yang dipancarkan meningkat dengan peningkatan frekuensi cahaya pancaran.
The intensity of the incident light affects the number of emitted electrons, and the frequency affects the maximum kinetic energy of the emitted electrons. Therefore, the maximum speed of the emitted electrons increases with increasing frequency of incident light.

7.3 Teori Fotoelektrik Einstein
Einstein's Photoelectric Theory

1. (a) Tenaga foton = tenaga kinetik maksimum + fungsi kerja
Photon energy = maximum kinetic energy + work function

$$hf = \frac{1}{2} mv^2_{max} + W_0$$

(b)



(c) (i) frekuensi minimum, kesan fotoelektrik / *minimum frequency, photoelectric effect*
(ii) tenaga minimum, membebaskan fotoelektron / *minimum energy, release a photoelectron*

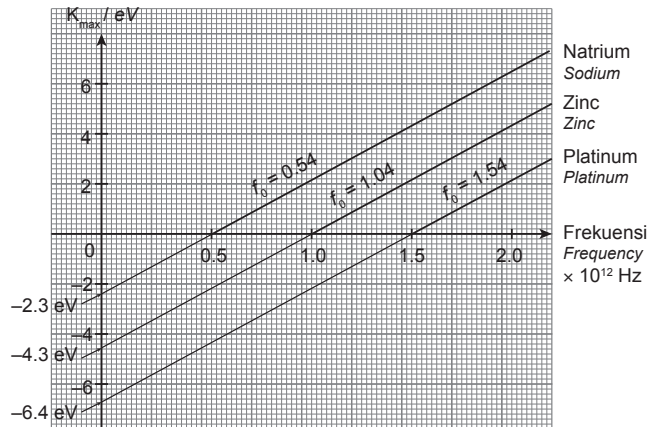
(d) Tiada elektron dapat dibebaskan dari permukaan logam. / *No electrons can be released from the metal surface.*

Menentukan fungsi kerja logam berdasarkan rumus, $W = hf_0$
Determine the work function of a metal based on the formula, $W = hf_0$

1.

Jenis logam *Type of metal*	Panjang gelombang *Wavelength of EM* / λ *nm*	Frekuensi ambang *Threshold frequency* $f_0 = c/\lambda \times 10^{15}$ Hz	Fungsi kerja *Work function* $W = (hf_0)/e$ / *eV*
Natrium *Sodium*	541	0.54	2.3
Zink *Zinc*	288	1.04	4.3
Platinum *Platinum*	192	1.54	6.4

(a), (b)



Menyelesaikan masalah melibatkan persamaan Einstein untuk kesan fotoelektrik
Solving problems involves Einstein's equation for photoelectric effects

Contoh 1

(a) Daripada graf / *from the graph*, frekuensi ambang / *threshold frequency*
pada A / *at A* $= 3 \times 10^{14}$ Hz

(b) Daripada graf / *from graph*, Fungsi kerja / *work function*,

$$W_0 = \frac{-2 \times 10^{-19} \times 6 \times 10^{-34}}{1.6 \times 10^{-19}\ \text{J}}$$
$$= -7.5 \times 10^{-34}\ \text{eV}$$

(c) Kecerunan graf / *gradient of graph* $= \frac{3 \times 10^{-19}}{(8.3) \times 10^{14}}$
$= 6.0 \times 10^{-34}$ J s

(d) Daripada graf / *From graph,*
apabila / *when* $f = 8 \times 10^{14}$ Hz,
$K_{max} = 3 \times 10^{-19}$ J

Contoh 2

(a) Logam *Q* / *Metal Q*

(b) Maka, fungsi kerja */ Therefore, work function Q*

$$= \frac{hf_0}{e}$$
$$= \frac{6.63 \times 10^{-34} \times 6 \times 10^{14}}{1.6 \times 10^{-19}}$$
$$= 2.48\ \text{eV}$$

(c) $K_{max} = \frac{hf}{e} - W_Q$
$$= \frac{6.63 \times 10^{-34} \times 6 \times 10^{14}}{1.6 \times 10^{-19}} - 2.48$$
$$= 3.315 - 2.48$$
$$= 0.835\ \text{eV}$$

Penghasilan arus fotoelektrik dalam sebuah litar sel foto
The production of photoelectric current in a photocell circuit

1. (a) Arus fotoelektrik akan terhasil dalam litar. / *Photoelectric current is produced in circuit.*

(b)

Cesium / ***Caesium***	**Litium** / ***Lithium***
Fungsi kerja / *Work function*, W = 2.14 eV	Fungsi kerja / *Work function*, W = 2.50 eV
Frekeunsi ambang / *Thereshold frequency*, $f_0 = 5.16 \times 10^{10}$ Hz	Frekeunsi ambang / *Thereshold frequency*, $f_0 = 6.03 \times 10^{10}$ Hz
Panjang gelombang maksimum untuk menghasilkan arus fotoelektrik, *Maximum wavelength to produce photoelectric current,* $\lambda = 579$ nm	Panjang gelombang maksimum untuk menghasilkan arus fotoelektrik, Maximum wavelength to produce photoelectric current, $\lambda = 496$ nm

Aplikasi kesan fotoelektrik
Applications of photoelectric effect

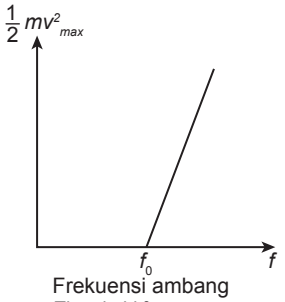
1. sel foto / *photocells*
(a) menukarkan tenaga suria, tenaga elektrik / *convert solar energy, electrical energy*
(b) cahaya berfrekuensi rendah, cahaya tampak, cukup untuk menghasilkan arus fotoelektrik / *low-frequency light, visible light, sufficient to produce photoelectric current*

2.
- pengesan cahaya untuk pembuka pintu automatik / *light sensor for automatic gate opener*
- meter cahaya dalam fotografl / *light meter in photography*
- sel suria dalam panel suria / *solar cell in building solar panels*

Tugasan 3

1. (a) $hf = \frac{1}{2} mv^2_{max} + W_0$
Di mana / *Where*,
hf ialah tenaga foton / *is photon energy*
$\frac{1}{2} mv^2_{max}$ ialah tenaga kinetik maksimum fotoelektron / *is maximum kinetic energy of photoelectron*
W_0 ialah fungsi kerja logam / *is work function of metal*

(b)



Frekuensi ambang
Threshold frequency

2. (a) Fungsi kerja / *work function*,
$W_0 = 4.22\ \text{eV} = 4.22 \times 1.6 \times 10^{-19}$ J
$= 6.75 \times 10^{-19}$ J
$W_0 = hf_0$
$6.75 \times 10^{-19} = 6.63 \times 10^{-34} \times f_0$

Frekuensi ambang / *threshold frequency*,
$$f_0 = \frac{6.75 \times 10^{-19}}{6.63 \times 10^{-34}}$$
$$= 1.02 \times 10^{15}\ \text{Hz}$$

(b) Tenaga foton / *Photon energy*,
$$E = hf = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{2.75 \times 10^{-9}}$$
$$= 7.23 \times 10^{-19}\ \text{J}$$

$K_{max} = E - W_0$
$\frac{1}{2} mv^2 = 7.23 \times 10^{-19} - 6.75 \times 10^{-19}$
$v^2 = \frac{0.48 \times 10^{-19} \times 2}{9.11 \times 10^{-31}} = 1.05 \times 10^{11}$
$v = 3.25 \times 10^5\ \text{m s}^{-1}$

(c) $eV_s = \frac{1}{2} m_e v^2_{max}$

$V_s = \frac{mv^2}{2e} = \frac{9.11 \times 10^{-31} \times (3.25 \times 10^5)^2}{2 \times 1.6 \times 10^{-19}}$

$= 0.30$ V

3. (a) $W_0 = 2.28$ eV $= 2.28 \times 1.60 \times 10^{-19} = 3.65 \times 10^{-19}$ J

$W_0 = hf_0$

$3.65 \times 10^{-19} = 6.63 \times 10^{-34} \times f_0$

Maka, frekuensi ambang, / *Thus, threshold frequency*,

$f_0 = \frac{3.65 \times 10^{-19}}{6.63 \times 10^{-34}}$

$= 5.51 \times 10^{14}$ Hz

Maka, julat frekuensi mengeluarkan elektron ialah 5.51×10^{14} Hz hingga 7.90×10^{14} Hz
Therefore, range of frequencies is 5.51×10^{14} Hz to 7.90×10^{14} Hz

(b) Untuk K_{max} tertinggi / *For the highest K_{max}*,

ambil / *take* $f = 7.90 \times 10^{14}$ Hz

$E = K_{max} + W_0$

$K_{max} = E - W_0$

$= hf - W_0$

$= 6.63 \times 10^{-34} \times 7.90 \times 10^{14} - 3.65 \times 10^{-19}$

$= 1.59 \times 10^{-19}$ J

PRAKTIS SPM 7

Soalan Objektif

1. D **2.** B **3.** D **4.** D **5.** C

Soalan Struktur

Bahagian A

1. (a) (i) Foton adalah satu pakej tenaga kuantum dalam ikatan diskrit yang dibawa oleh gelombang cahaya.
Photon is a package of quantum energy in discrete bundles carried by light waves.

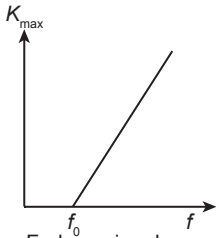
(ii) $\frac{1}{2} mv^2_{mak} = hf - W_0$

m = jisim elektron / *mass of electron*
v_{mak} = laju maksium fotoelektron / *maximum speed of photoelectron*
h = Pemalar Planck / *Planck's constant*
f = frekuensi gelombang elektromagnet / *frequency of electromagnetic waves*
W_0 = fungsi kerja / *work function*

(iii) Dalam persamaan ini, tenaga foton (hf) dibekalkan tenaga minimum (W_0) yang diperlukan untuk mengeluarkan elektron dari logam dan tenaga bakinya dipindah sebagai tenaga kinetik maksimum ($\frac{1}{2} mv^2_{mak}$) fotoelektron.
In this equation, the photon energy (hf) is used to supply the minimum energy (W_0) required to expel the electron from the metal and the remaining energy becomes the maximum kinetic energy ($\frac{1}{2} mv_{mak}^2$) of the photoelectron.

(b) (i)
- Tenaga kinetik maksimum fotoelektron yang dikeluarkan itu tidak bergantung pada keamatan cahaya tuju.
The maximum kinetic energy of the emitted photoelectrons does not depend on the intensity of the incident light.
- Fotoelektron hanya dapat dikeluarkan apabila frekuensi cahaya tuju lebih tinggi daripada frekuensi ambang.
Photoelectrons can only be emitted when the frequency of the incident light is higher than the threshold frequency.

(ii)



Frekuensi ambang
Threshold frequency

(iii) $\frac{1}{2} mv^2_{mak}$

$= hf - W_0$

$= \frac{hc}{\lambda} - W_0$

$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{350 \times 10^{-9}} - 2.30 \times 1.6\ 10^{-19}$

$= 2.00 \times 10^{-19}$ J

$v_{mak} = \sqrt{\frac{2 \times 2.00 \times 10^{-19}}{9.11 \times 10^{-31}}}$

$= 6.63 \times 10^5$ m s^{-1}