SULIT
960/1
SEPTEMBER 2012

PEPERIKSAAN PERCUBAAN
SIJIL TINGGI PELAJARAN MALAYSIA
NAMA SEKOLAH

PHYSICS
PAPER 1
One hour and fourty-five minutes

Instructions to candidates:

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

There are **fifty** *questions in this paper. For each question, four suggested answers are given. Choose* **one** *correct answer and indicate it on the multiple-choice answer sheet provided.*

Read the instructions on the multiple-choice answer sheet very carefully.

Answer **all** *questions. Marks will not be deducted for wrong answers.*

Arahan kepada calon:

JANGAN BUKA BUKU SOALAN INI SEHINGGA ANDA DIBENARKAN BERBUAT DEMIKIAN.

Ada **lima puluh** *soalan dalam kertas ini. Bagi setiap soalan, empat cadangan jawapan diberikan. Pilih* **satu** *jawapan yang betul dan tandakan jawapan itupada helaian jawapan aneka pilihan yang dibekalkan.*

Baca arahan pada helaian jawapan aneka pilihan itu dengan teliti.

Jawab **semua** *soalan. Markah tidak akan ditolak bagi jawapan yang salah.*

Buku Data dibekalkan.

1.Which of the following constants have dimensions that do not include the dimension of length?

$$F = \frac{GmM}{r^2}\ ,\ E = \frac{hc}{\lambda}\ \ ,\ \ F = ce\ ,\ E = \frac{1}{2}kT$$

A. gravitational constant,G
B Planck's constant,h
C spring constant,c
D Boltzman's constant,k

2. The wheel of a helicopter is suddenly detached while the helicopter is flying horizontally with a speed of 144 km h^{-1} at a height of 500 m from the ground. What is the horizontal distance travelled by the wheel before it touches the ground?

A 200 m **B** 400 m **C** 500 m **D** 600 m

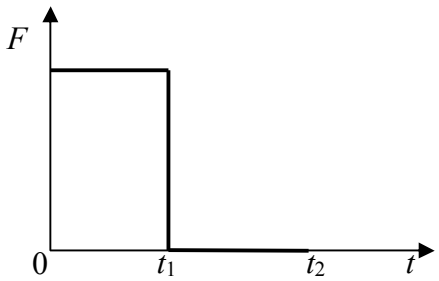
3. A jet of water with uniform velocity v hits a vertical wall normally and produces a pressure p on the wall. If the velocity of the water jet is $2v$, what is the pressure exerted on the wall?
[Assume that the water does not rebound from the wall .]

A $\frac{3}{2}p$ **B** $\sqrt{2}p$ **C** $2p$ **D** $4p$

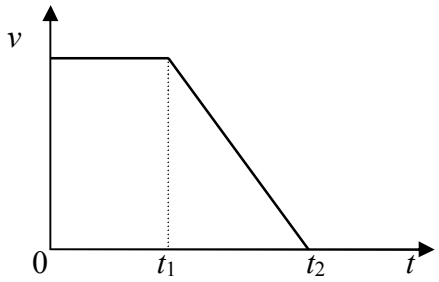
4. Two bodies P and Q (of equal mass), travelling towards one another on a level frictionless track at speed u and v respectively, making an elastic collision.
At some instant during the collision, P is brought momentarily to rest. What is the speed of Q at that instant?

A $(v-u)$ **B** $2\,(v-u)$ **C** $\frac{1}{2}(v-u)$ **D** $\sqrt{(uv)}$

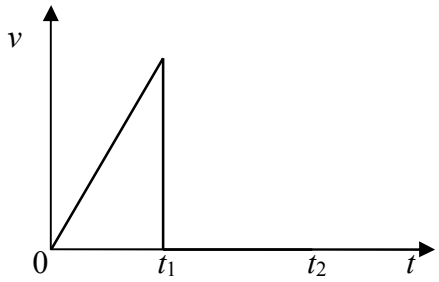
5. The diagram below shows how the resultant force F acting on a body initially at rest changes with time t .



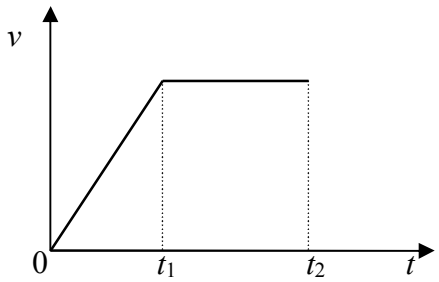
Which of the graphs below shows the change in velocity v of the body with time t ?



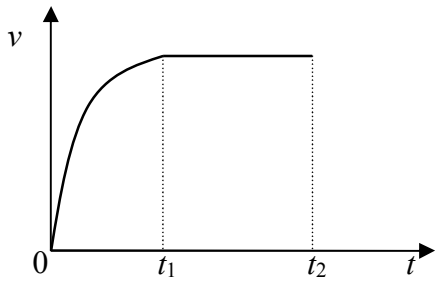
A



B

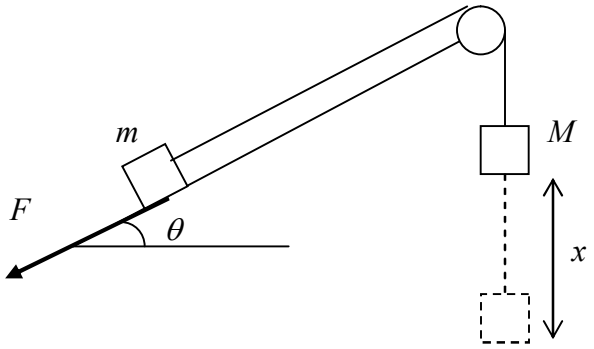


C



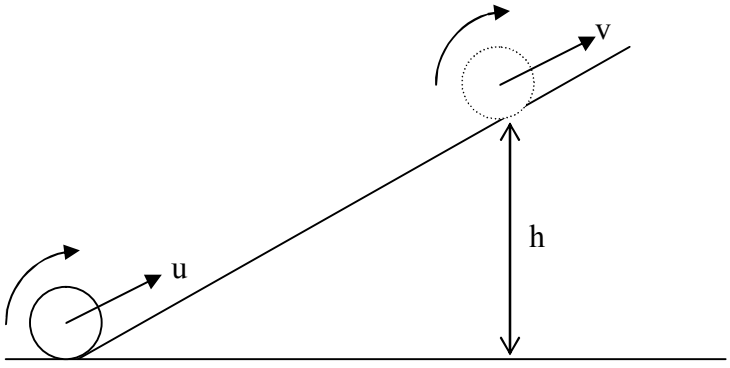
D

6. A mass *m* moves on a rough plane inclined at an angle θ to the horizontal and, when moving, experiences a constant frictional force *F*. Mass *M* is attached to it by means of a light inelastic cord running over a smooth pulley. Mass *M* is allowed to fall a vertical distance *x* , causing *m* to move up the plane as shown in the diagram below.
What is the work done against friction?



A *Fx* **B** *mgx* **C** *Mgxsin*θ **D** *Mgxsin*θ - *Fx*

7. The diagram below shows a ball of mass *m* and radius *r* moving at a translational speed *u* and rolling up an inclined plane without sliding. After reaching a height of *h* , the speed of the ball is *v*.



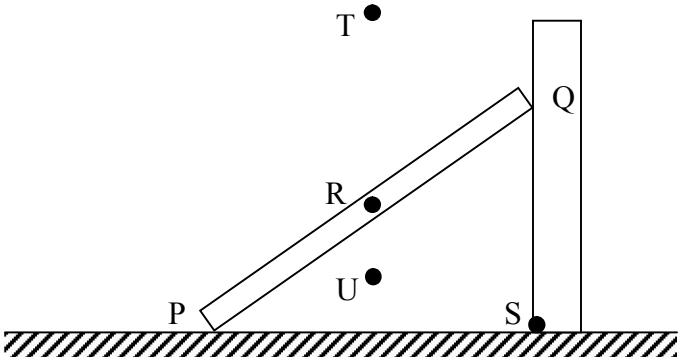
If *g* is the acceleration of free fall and the moment of inertia of the ball about its rotation axis is $\frac{2}{3}mr^2$, which expression is equal to h ?
[The effect of friction is negligible]

A $\frac{u^2 - v^2}{3g}$ **B** $\frac{u^2 - v^2}{2g}$ **C** $\frac{5(u^2 - v^2)}{6g}$ **D** $\frac{r^2(u^2 - v^2)}{3g}$

8. A round cylinder was rotating freely along its axis with kinetic energy E_k. It was stopped gradually by a uniform frictional force in time t which was applied tangentially to its surface. At time $\frac{t}{2}$ after this frictional force was applied, what was the kinetic energy of the cylinder ?

A $\frac{E_k}{4}$ **B** $E_k\left[1-\left(\frac{1}{\sqrt{2}}\right)\right]$ **C** $\frac{E_k}{2}$ **D** $\frac{3E_k}{4}$

9. The diagram below shows a ladder PQ with a centre of mass R resting on a wall QS.



The resultant forces at P and Q are F_P and F_Q respectively. If the ladder is in equilibrium, F_P and F_Q must act through point

A R **B** S **C** T **D** U

10. Two stationary particles of masses M_1 and M_2 are at a distance d apart. A third particle , lying on the line joining the particles, experiences no resultant gravitational force. What is the distance of this particle from M_1?

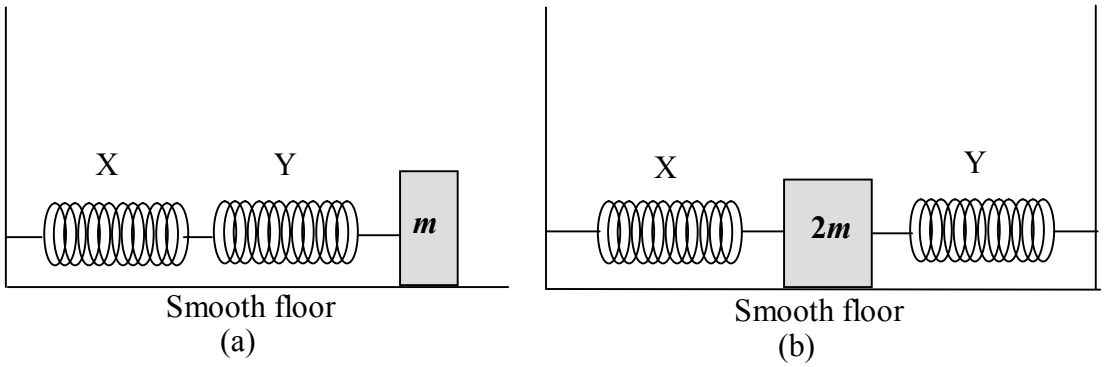
A $d\sqrt{\frac{M_1}{M_2}}$ **B** $d\sqrt{\frac{M_1}{M_1+M_2}}$ **C** $d\frac{M_1}{M_1+M_2}$ **D** $d\frac{\sqrt{M_1}}{\sqrt{M_1}+\sqrt{M_2}}$

11. Which of the following relationships below correctly relates the potential energy U, kinetic energy T and the total energy E of a satelite?

A $U = -2T = 2E$
B $U = -T = -E$
C $U = -\frac{1}{2}T = -\frac{1}{2}E$
D $U = T = \frac{1}{2}E$

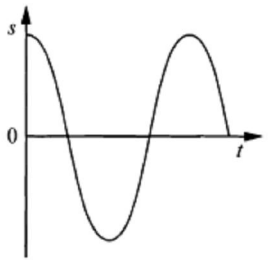
12. A body performing simple harmonic motion has a displacement x given by the equantion $x = 30 \sin 50t$, where t is the time in seconds. What is the frequency of oscillation?
A 0.020 Hz **B** 0.13 Hz **C** 8.0 Hz **D** 30 Hz

13. Two similar helical spring X and Y can be connected to an object of mass m and an object of mass $2m$ in two different arrangement as shown below.

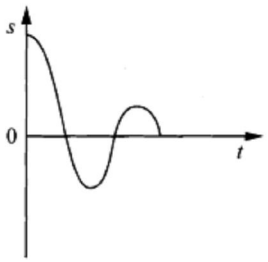


The objects undergo simple harmonic motion when displaced slightly along the axis of the springs and then released. What is the ratio of the period of oscillation of object m to the period of oscillation of object $2m$?
A 1:1 **B** 1:2 **C** $\sqrt{2}$:1 **D** 2:1

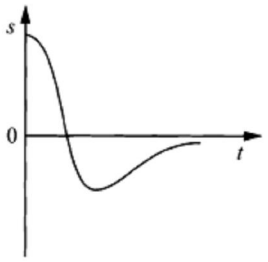
14. A spring-mass system experiences critical damping. Which of the following graphs represents the variation of the displacement *s* with time *t* of the motion of the mass ?



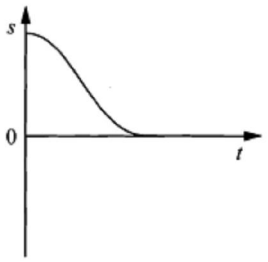
A



B

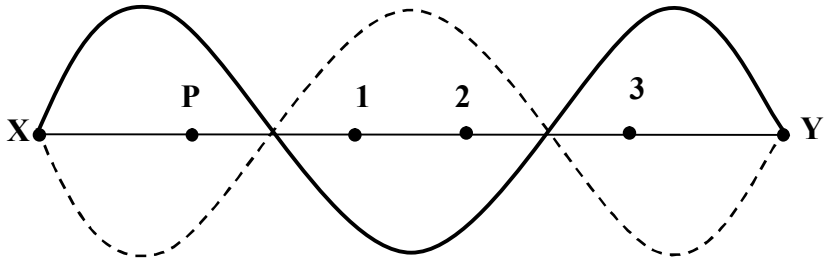


C



D

15. A standing wave is set up on a stretched string **XY** as shown in the diagram below.



At which point(s) will the oscillation be exactly in phase with that at P ?

A 1 and 2 only **B** 2 and 3 only **C** 2 only **D** 3 only

16. A progressive wave P in a medium is represented by the wave equation $y = 0.1\sin\left(200\pi t - \frac{20\pi x}{17}\right)$. Another progressive wave Q moves in the opposite direction as wave P in the same medium. Which of the equations below represents the wave Q if the wavelength of Q is twice that of P ?

A $y = 0.1\sin\left(100\pi t + \frac{10\pi x}{17}\right)$

B $y = 0.1\sin\left(100\pi t - \frac{10\pi x}{17}\right)$

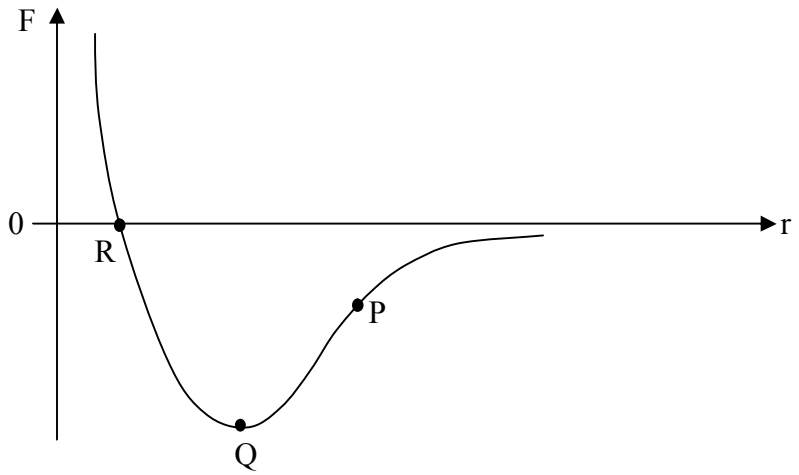
C $y = 0.1\sin\left(200\pi t + \frac{10\pi x}{17}\right)$

D $y = 0.1\sin\left(200\pi t - \frac{10\pi x}{17}\right)$

17. If the level of intensity of a sound is raised by 10 dB, what is the ratio of the new sound intensity to the original sound intensity ?

A 0.1 **B** 1 **C** 10 **D** 10^{10}

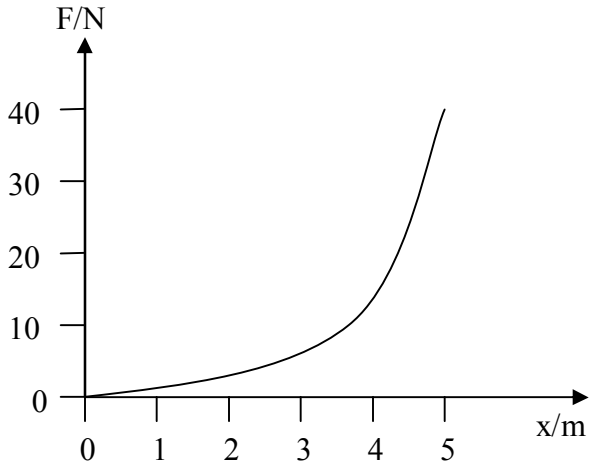
18. The graph below shows how the force F between two atoms changes with their atomic separation r.



Which of the following statements are correct deductions from the graph?

A From point P to point Q, the nett force between the atoms is a decreasing attractive force.
B From point Q to point R, the nett force between the atoms is a decreasing repulsive force.
C At point Q, the nett force between the atoms is a maximum attractive force.
D At point R, the potential energy of the atom is zero.

19. The force F required to extend a sample of rubber by a length *x* was found to vary as shown in the diagram below.

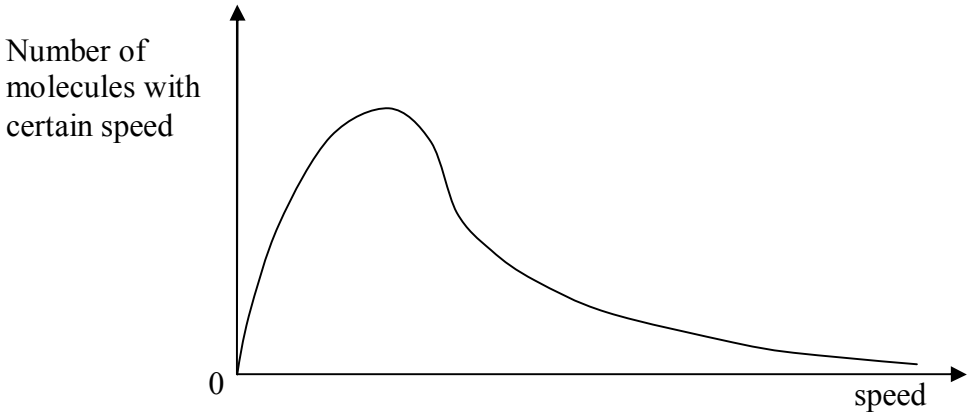


The energy stored in the rubber for an extension of 5 m was
A more than 200 J
B between 100 J and 200 J
C 100 J
D less than 100 J

20. The ratio of the molar heat capacity of an ideal gas is a. What is the number of degrees of freedom of the gas?

A $\frac{2a}{a-1}$ **B** $\frac{a-1}{2}$ **C** $\frac{a+2}{a}$ **D** $\frac{2}{a-1}$

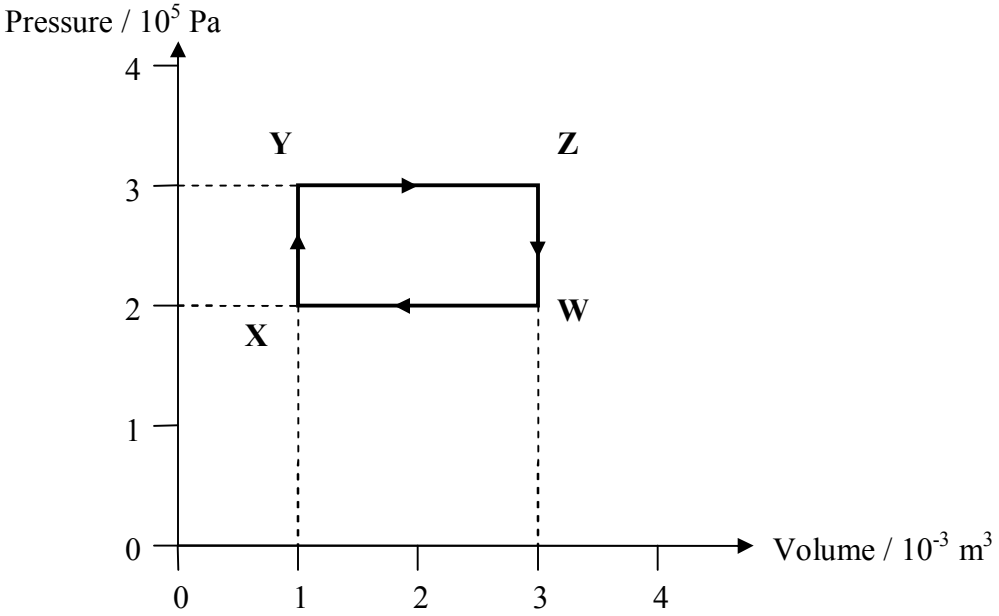
21. The graph below shows the molecular speed distribution of a gas in a container at certain temperature.



Which of the following statements are correct deductions from the above graph?

A The graph represents the molecular speed distribution in one direction.
B There are many molecules with zero speed.
C All molecules moves with the same speed.
D The percentage of molecules with speed less than the mod speed is less than 50%.

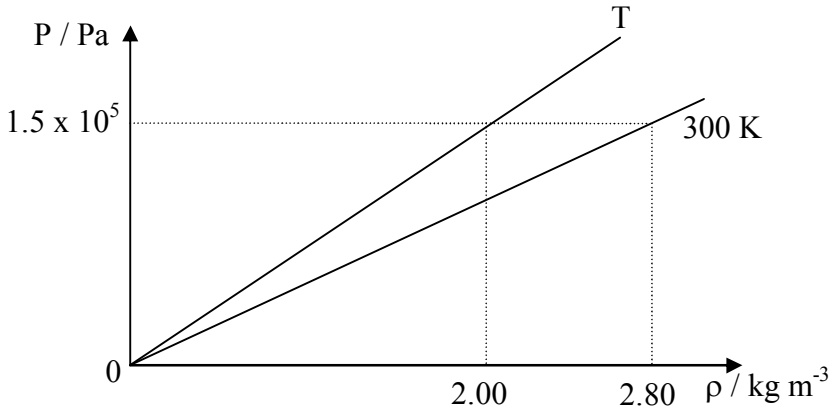
22. A gas undergoes the cycle of pressure and volume changes **W → X → Y → Z → W** as shown in the diagram below.



What is the work done for the process **W → X → Y → Z → W** ?

A - 600 J **B** - 200 J **C** 200 J **D** 600 J

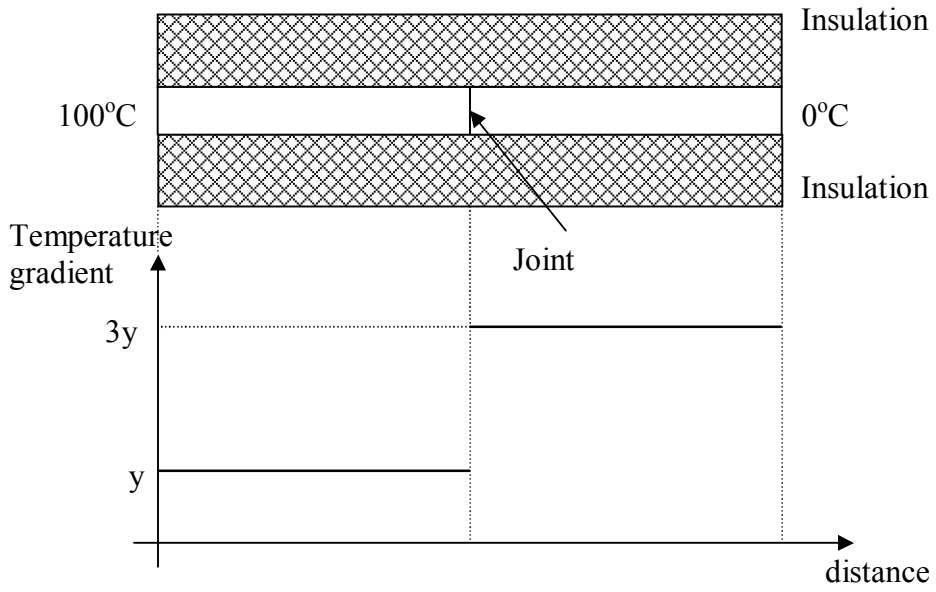
23. The graph below shows the change in pressure p with density ρ of an ideal gas at temperature T and 300 K.



What is the temperature T ?

A 214 K **B** 254 K **C** 355 K **D** 420 K

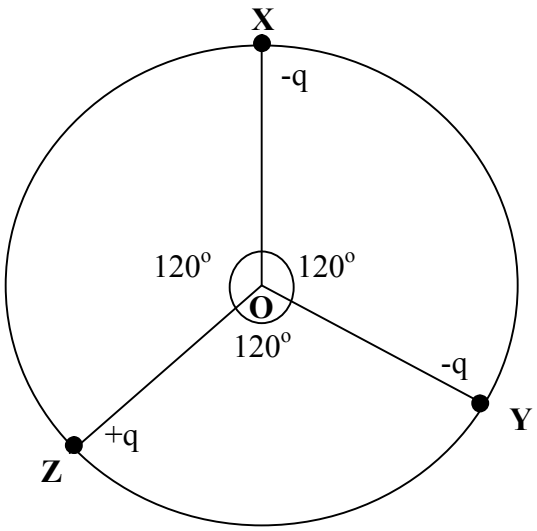
24. Two metal rods of the same length and cross sectional area is connected end to end. The composite rod is insulated perfectly and its exposed ends are maintained at 100^oC and 0^oC as shown in the diagram (a) below. When equilibrium is achieved , the variation in temperature gradient with distance from the hot end of the composite rod is shown in diagram (b).



What is the temperature at the joint of the composite rod ?

A 33^oC **B** 50^oC **C** 67^oC **D** 75^oC

25. The diagram below shows charges +q, +q and –q which are fixed at points X, Y and Z of a circle respectively.



The resultant electric field at centre O of the circle is in the direction of

A OY **B** OZ **C** YO **D** ZO

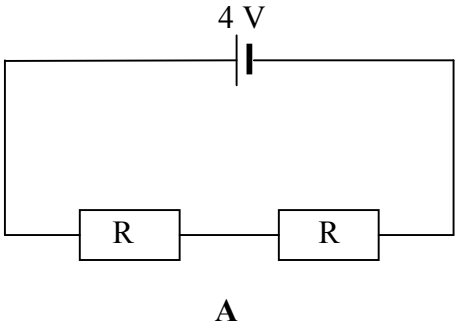
26. A capacitor discharges through a resistance wire with time constant τ_1. When the wire is replaced by another wire of the same material and length but double the diameter, the time constant is τ_2. What is the ration of $\tau_2 : \tau_1$?

A 1: 4 **B** 1 : 2 **C** 2 : 1 **D** 4 : 1

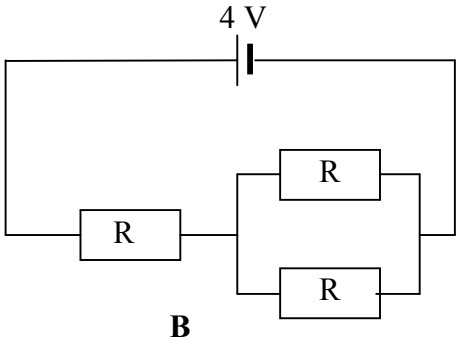
27. A 2μF capacitor charged initially by a 30 V source is disconnected from the source and then connected to an uncharged 1 μF capacitor.
What is the final potential difference across the capacitors ?

A 10 V **B** 15 V **C** 20 V **D** 30 V

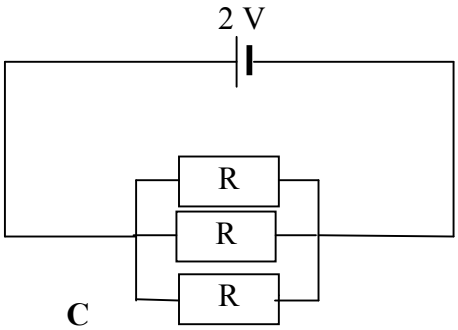
28. Which of the following circuits below uses the largest amount of electrical power?



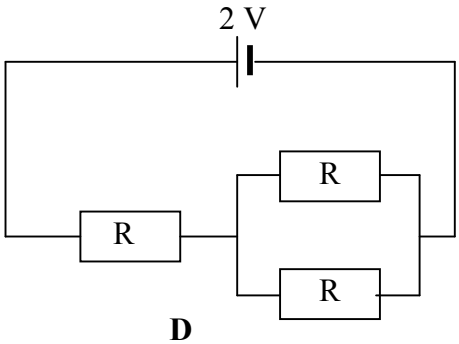
A



B

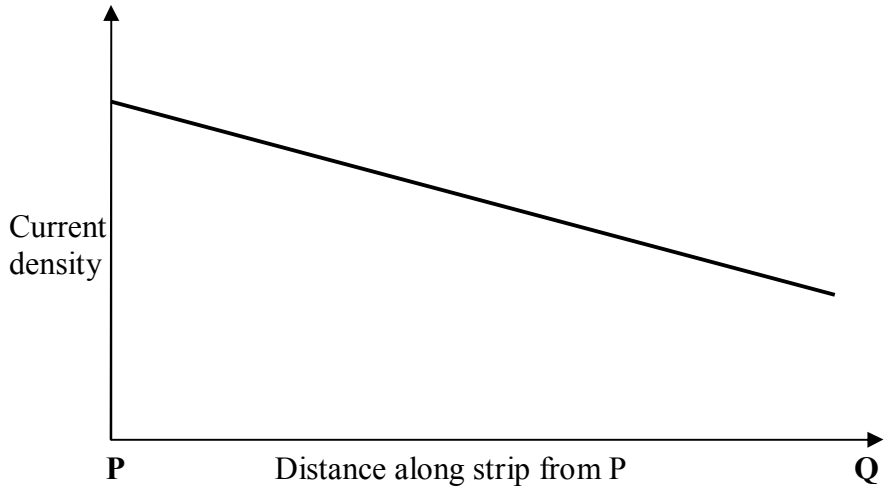


C



D

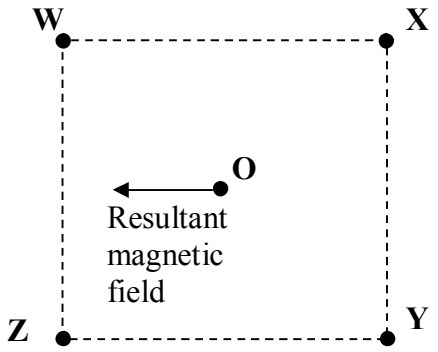
29. An electric current flows along an insulated strip PQ of metallic conductor. The current density in the strip varies as shown in the graph below.



Which one of the following statements could explain this variation ?

A The current at P is greater than the current at Q.
B The potential gradient along the strip is uniform.
C The strip is narrower at P than at Q.
D The resistance per unit length of the strip is constant.

30. Four parallel conductors, carrying equal currents, pass vertically through the four corners of a square **WXYZ** . In two conductors, the current is flowing into the page, and in the other two out of the page.



In what directions must the current flow to produce a resultant magnetic field in the direction as shown at O, the centre of the square?

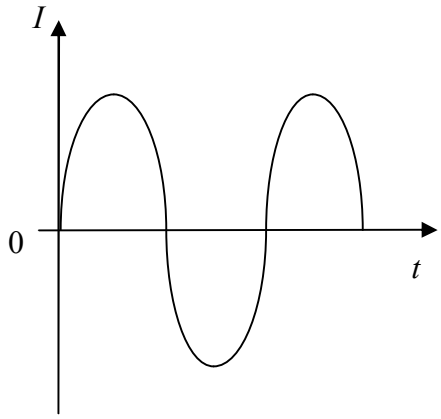
	Into the page	Out of the page
A	W and X	Y and Z
B	W and Y	X and Z
C	X and Z	W and Y
D	Y and Z	W and X

31. An electron moves into a uniform magnetic field with a certain velocity. If the velocity of the electron is perpendicular to the direction as the magnetic field, which statement about the subsequent motion of the electron in the magnetic field is true?

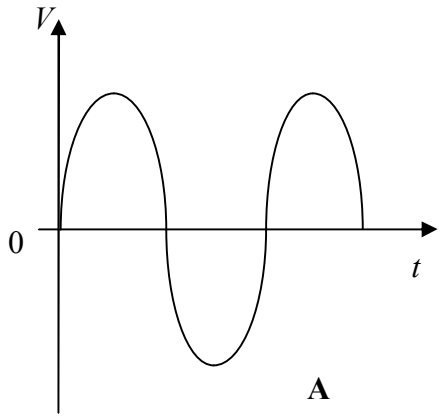
A The electron accelerates to the left.
B The electron accelerates to the right.
C The electron continues to move with its original velocity.
D The electron is deflected and moves in a circle at constant speed.

32. When the load increases, the speed of rotation of an electric motor decreases and the current flowing through it increases. This occurs because
A the back emf decreases
B the frictional forces decreases
C the inductance of the armature coil increases
D the resistance of the armature coil increases

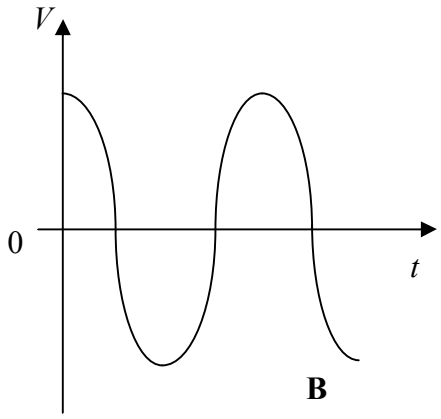
33. The diagram below shows the variation of current *I* across a capacitor with time *t* ?



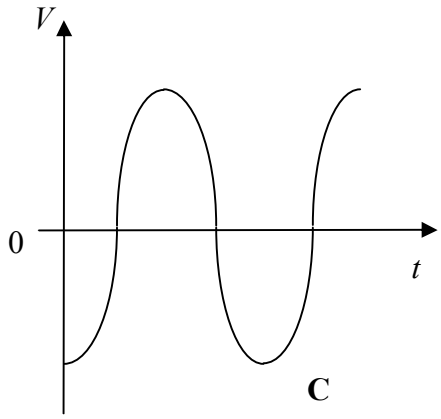
Which of the following graphs shows the variation of current *I* through the capacitor with time *t* ?



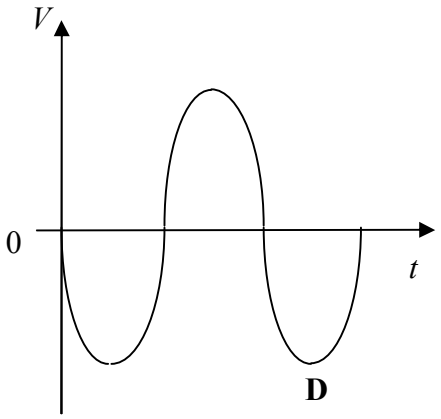
A



B

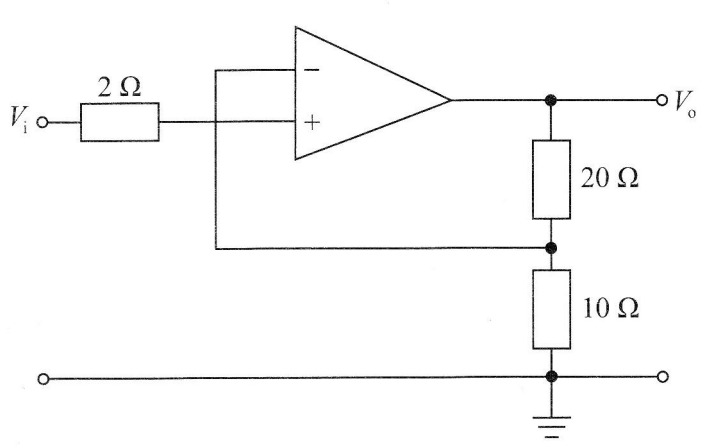


C



D

34. A non-inverting amplifier circuit is shown in the diagram below.



What is the gain of the circuit?

A 2 **B** 3 **C** 5 **D** 6

35. The wavelength of a type of electromagnetic wave is 5 X 10^{-8} m. What is the name of this wave ?

A X-ray **B** Visible light **C** Radio wave **D** Ultraviolet ray

36. What is the focal length of a drop of water in the form of a sphere with radius 4 mm? [The refractive index of water = $\frac{4}{3}$]

A 2 mm **B** 4 mm **C** 6 mm **D** 8 mm

37. An object is placed 20 cm from a concave mirror with radius of curvature of 10 cm. The image formed is

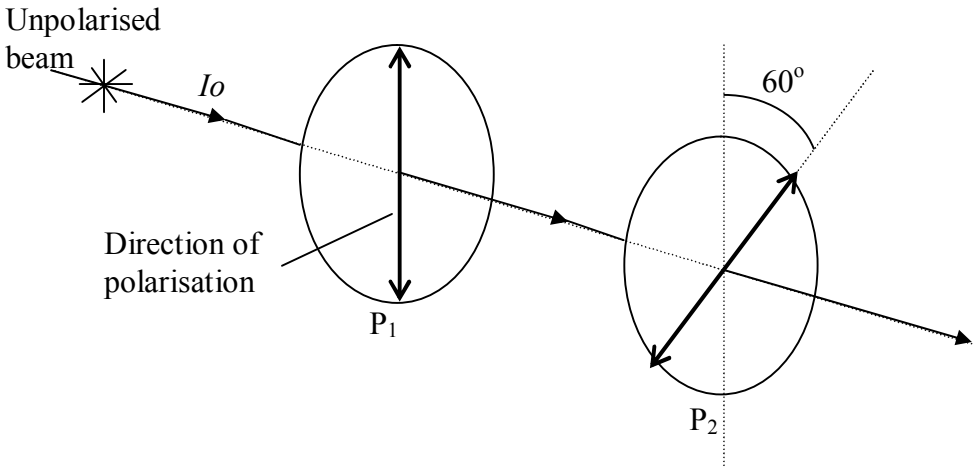
A 6.7 cm in front of the mirror and is diminished.
B 6.7 cm behind the mirror and is enlarged.
C 10.0 cm in front of the mirror and is diminished.
D 10.0 cm behind the mirror and is enlarged.

38. The diagram below shows the arrangement of Young's double-slit experiment. S is the monochromatic light source of wavelenth λ. The centre of the interference pattern which is produced on the screen is located at O with OS being perpendicular to the two slits S_1 and S_2. P is the location of the first dark band.

Which of the following is true about the optical path difference between S_1P dand S_2P?

A $\frac{1}{2}\lambda$ **B** λ **C** $1\frac{1}{2}\lambda$ **D** 2λ

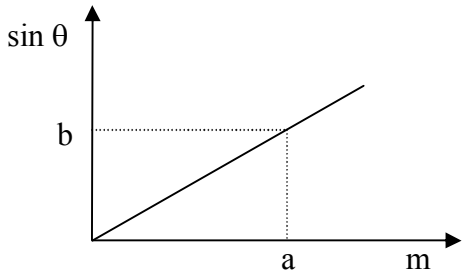
39. The diagram below shows a beam of unpolarised light of intensity *Io* which passes through polarisers P_1 and P_2.



The intensity of the light after passing through P_2 is

A $\frac{1}{8}Io$ **B** $\frac{1}{4}Io$ **C** $\frac{3}{8}Io$ **D** $\frac{3}{4}Io$

40. An experiment was carried out to determine the wavelength of monochromatic light using a diffraction grating which has N lines per unit length. A diffraction angle θ for each order m was determined. The graph shows the variation of sin θ with m.



What is the wavelength of the light ?

A $\frac{a}{Nb}$ **B** $\frac{b}{Na}$ **C** $\frac{Na}{b}$ **D** $\frac{Nb}{a}$

41. In a photoemission experiment, the wavelength of the light incident on the target material is increased. What is the effect of this change of wavelength on the photoelectrons produced ?

A The number of photoelectrons produced increases.
B The number of photoelectrons produced decreases.
C The maximum kinetic energy of the photoelectrons decreases.
D The maximum kinetic energy of the photoelectrons increases.

42. Which of the following is correct for the kinetic energy E and momentum p of a particle of de Broglie wavelength λ ?

	Energy	Momentum
A	$E = \frac{hc}{\lambda}$	$p = \frac{h}{\lambda}$
B	$E = \frac{1}{2}mv^2$	$p = \frac{h}{\lambda}$
C	$E = \frac{hc}{\lambda}$	$p = \frac{E}{c}$
D	$E = \frac{1}{2}mv^2$	$p = \frac{E}{c}$

43. Listed below are five phenomena connected with photons and / or charged particles.

1. alpha-particle emission
2. beta-particle emission
3. line emission spectra
4. line absorbtion spectra
5. electron diffraction

Which of these phenomena give direct evidence for the existence of discrete electronic energy levels in atoms ?

A 1 and 5 only
B 2 and 3 only
C 3 and 4 only
D 1,2,3,4 and 5

44. Which statement about Bohr's postulate for the hydrogen atom is **not** true?

A The electron revolves in a circular orbit about the proton.
B The electron revolving in a certain orbit does not emit radiation.
C The electron behaves as a stationary wave in a certain orbit.
D Radiation is emitted when the electron falls from an orbit of high energy to one of low energy.

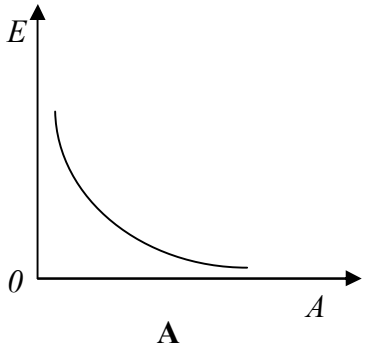
45. A photon of X-ray of the minimum wavelength is produced by the

A deceleration of electrons by the target atoms.
B removal of an electron in an inner shell of a target atom.
C loss of all the kinetic energy of an electron in a single collision with a target atom.
D elastic collisions between electrons and the target.

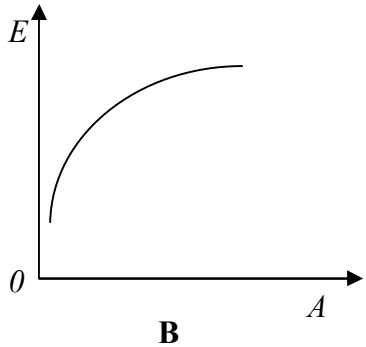
46. What is meant by population inversion in laser production?

A There are more atoms in the ground state than in the excited state
B There are more atoms in the excited state than in the ground state
C Excited-state atoms are equal in number with ground -state atoms
D Ground- state atoms become excited- state atoms by absorption of photons

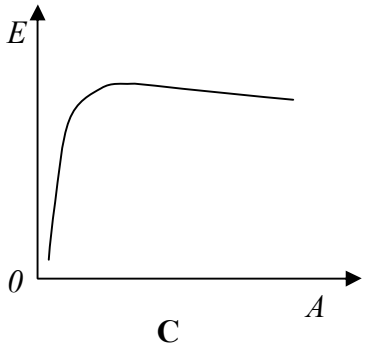
47. Which graph represents the variation of binding energy per nucleon E with mass number A?



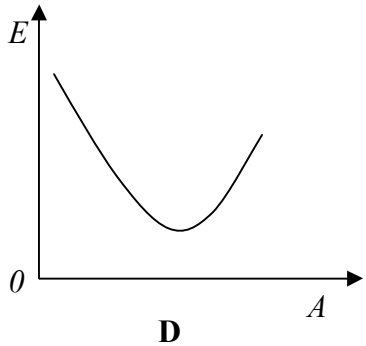
A



B



C



D

48. The rate of radioactive decay $\frac{dN}{dt}$ for N number of radioactive nuclei is $\frac{dN}{dt} = -\lambda N$.

A lower decay constant λ means that the

A activity is higher
B decay energy is higher
C half-life is shorter
D probability of decay per second is lower

49. Which of the following radioactivities is **not** likely to occur?

A $^{230}_{90}Th \rightarrow ^{226}_{88}Ra + \alpha$
B $^{227}_{89}Ac \rightarrow ^{227}_{90}Th + \beta$
C $^{222}_{86}Rn \rightarrow ^{218}_{84}Po + \alpha$
D $^{238}_{92}U \rightarrow ^{239}_{93}Np + \beta$

50. All the following statements describe how a lepton differs from a hadron, ***except***

A Lepton is an elementary particle.
B Lepton does not experience strong force.
C Lepton is always lighter than hadron.
D Lepton experiences weak force.

Values of Constants (Nilai Pemalar)

Speed of light in free space	(Laju cahaya dalam ruang bebas)	$c = 3.00 \times 10^{8}$ ms^{-1}
Permeability of free space	(Ketelapan ruang bebas)	$\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}
Permittivity of free space	(Ketelusan ruang bebas)	$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}
		$\approx (1/(36\pi)) \times 10^{-9}$ F m^{-1}
Magnitude of electronic charge	(Magnitud cas electron)	$e = 1.60 \times 10^{-19}$ C
Planck constant	(Pemalar Planck)	$h = 6.63 \times 10^{-34}$ J s
Unified atomic mass unit	(Unit jisim atom bersatu)	u = 1.66×10^{-27} kg
Rest mass of electron	(Jisim rehat electron)	$m_e = 9.11 \times 10^{-31}$ kg
Rest mass of proton	(Jisim rehat proton)	$m_p = 1.67 \times 10^{-27}$ kg
Molar gas constant	(Pemalar gas molar)	R = 8.31 J K^{-1} mol^{-1}
Avogadro constant mol^{-1}	(Pemalar Avogadro)	L, $N_A = 6.02 \times 10^{23}$
Boltzmann constant	(Pemalar Boltzmann)	$k = 1.38 \times 10^{-23}$ J K^{-1}
Gravitational constant Nm^{2}kg^{-2}	(Pemalar gravity)	$G = 6.67 \times 10^{-11}$
Acceleration of free fall	(Pecutan jatuh bebas)	$g =$ 9.81 m s^{-2}

NAMA:……. **TINGKATAN**:……

SULIT

960/2

SEPTEMBER 2012

PEPERIKSAAN PERCUBAAN
SIJIL TINGGI PELAJARAN MALAYSIA
NAMA SEKOLAH

PHYSICS
PAPER 2
Two and a half hours

Instructions to candidates:

Answer **all** *the questions in Section A in the spaces provided. All working* **must** *be shown. For calculations, relevant values of constants in the Data Booklet* **must** *be used. For numerical answers, units* **must** *be quoted wherever they are appropriate.*

Answer any **four** *questions from Section B. For this section, write your answers on the answer sheets provided. Begin each answer on a fresh sheet of paper, and arrange your answers in numerical order. Tie your answer sheets to this booklet.*

Answers may be written in either English or Malay.

Arahan kepada calon:

Jawab **semua,** *soalan dalam Bahagian A dalam ruang yang disediakan. Semua kerja* **mestilah** *ditunjukkan. Bagi penghitungan, nilai pemalar yang berkaitan dalam Buku Data* **mestilah** *digunakan. Bagijawapan berangka, unit* **mestilah** *dinyatakan di mana-mana yang sesual*

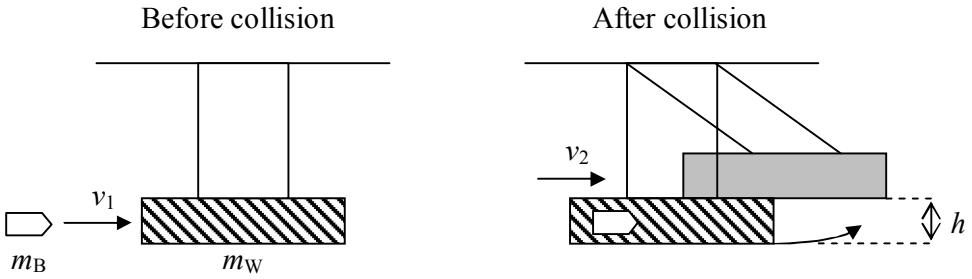
Jawab mana-mana **empat** *soalan daripada Bahagian B. Untuk bahagian ini, tulis jawapan anda pada helaian jawapan yang dibekalkan. Mulakan setiap jawapan pada helaian kertas yang baru, dan susunjawapan anda mengikut tertib berangka. Ikat helaian jawapan anda bersama dengan buku soalan ini.*

Jawapan boleh ditulis dalam bahasa Inggeris atau bahasa Melayu.

Buku Data dibekalkan.

For examiner's use (Untuk kegunaan pemeriksa)	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
Total (Jumlah)	

1 The diagram below shows a ballistic pendulum. A bullet of mass m_B makes a completely inelastic collision with a block of wood of mass m_W, which suspended like a pendulum. After the impact, the block swings up to a maximum height, h with velocity v_2.



(a) Find the initial speed of bullet, v_1 in terms of m_B, m_W, g and h.

[3 *marks*]

(b) If the mass of bullet is 5.00 g and mass of wood is 2.00 kg, calculate the initial speed of bullet, v_1 when the block of wood swings at a height of 3.00 cm.

[2 *marks*]

2 After finished watching a movie on a Blu-ray and the disc slows down to a stop. The initial angular velocity of the disc is 27.5 rad s^{-1}, and its constant angular deceleration is 10.0 rad s^{-2}.

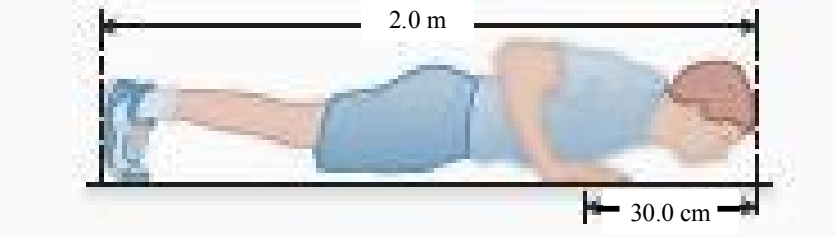
(a) What is the angular velocity after 0.30 s?

[2 *marks*]

(b) How many revolutions have been made at this same time?

[3 *marks*]

3 An athlete of mass 82 kg and 2.0 m tall is doing push-ups as shown in the diagram below. His centre of mass is 1.15 m from the bottom of his feet, and the centre of his palms is 30.0 cm from the top of his head.



(a) Label all the forces that act on the athlete. [1 *mark*]

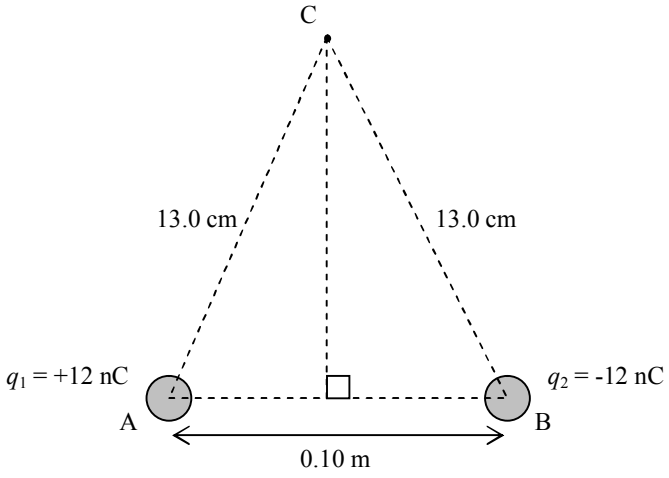
(b) Find the force that the floor exerts on each of his feet and on each hand.

[4 *marks*]

4 A bedroom contains about 2500 moles of air. Find the change in the internal energy when the air is cooled from 35.0 ^{o}C to 26 ^{o}C at a constant pressure. Assume the gas as an ideal gas of diatomic molecules.

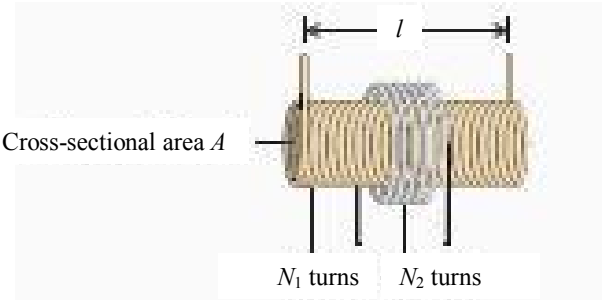
[5 *marks*]

5 Point charges at A q_1 = +12 nC and at B q_2 = -12 nC are 0.10 m apart. Label the electric fields intensity that act at C and find the resultant electric field intensity at C.



[5 *marks*]

6 A long solenoid with cross-sectional area A and N_1 turns is surrounded at its centre by a coil with N_2 turns as shown in the diagram below.



(a) Express the mutual inductance M in terms of μ_o, N_1, N_2, A and l.

[3 *marks*]

(b) If the mutual inductance M is 25 μH, cross-sectional area A is 10 cm^2 and number of turn N_2 is 10 turns, find the number of turns per unit length for the long solenoid.

[2 *marks*]

7 A laser pointer with a power output of 5.00 mW emits red light with wavelength 650 nm.

(a) What is the magnitude of the momentum of each photon?

[2 *marks*]

(b) How many photons does the laser pointer emit each second?

[3 *marks*]

8 Nuclei nickel $^{62}_{28}Ni$ has the highest binding energy per nucleon of all nuclides. Atomic mass unit of $^{62}_{28}Ni$ is 61.928349 u

Atomic mass unit of proton is 1.007825 u
Atomic mass unit of neutron is 1.008665 u

(a) Determine the mass defect of $^{62}_{28}Ni$.

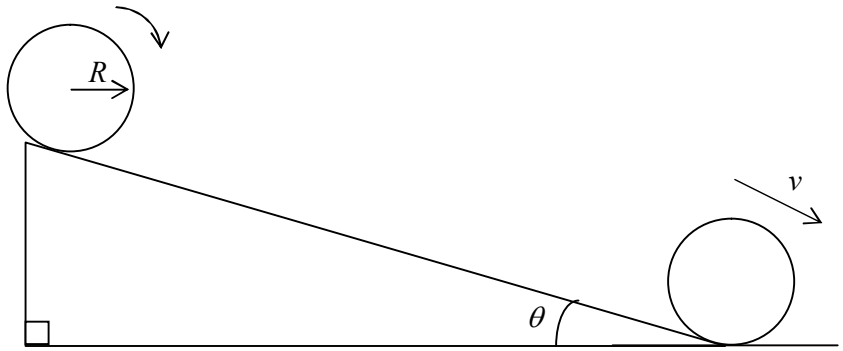
[2 *marks*]

(b) Calculate the binding energy per nucleon of $^{62}_{28}Ni$.

[3 *marks*]

9(a) Define moment of inertia of a rigid body. [2 *marks*]

(b) The diagram below shows a solid sphere of mass M and radius R rolling without slipping from rest on an inclined plane at an angle θ to the horizontal. The moment of inertia of the sphere about its axis is $\frac{2}{5}MR^2$.



(i) State the force which enables the cylinder to roll without slipping. [1 *mark*]

(ii) Copy the diagram above, mark and label the forces that act on the cylinder. [3 *marks*]

(iii) Derive an expression of the kinetic energy of the sphere in terms of M and v. [3 *marks*]

(iv) By using work-energy theorem and linear motion equations, find linear acceleration a of the rolling motion in terms of θ and g. [3 *marks*]

(v) Calculate the linear acceleration a if $\theta = 30^o$. State whether rolling or sliding has large linear acceleration. [3 *marks*]

10(a) Sketch graphs using the same axis to show how the potential energy U and the force between two atoms F depend on the separation r of the atoms. On the graph, labeled the equilibrium separation r_o. [3 *marks*]

(b) The potential energy U between the two atoms in a solid is represented by the equation

$$U = \frac{A}{r^{12}} - \frac{B}{r^6}$$

where A and B are constant and r is the interatomic separation.

(i) Write an equation to show the relationship between force F and potential energy U and hence deduce an expression of F for the two atoms in the solid.
[3 *marks*]

(ii) Determine the equilibrium separation r_o between the atoms in terms of A and B.
[2 *marks*]

(iii) What is the minimum potential energy U_{min} in terms of A and B?
State the physical significance of U_{min}. [4 *marks*]

(iv) Find the separation of r at the breaking point of the solid in terms of A and B.
[Breaking point is where the two atoms are separated completely]
[3 *marks*]

11(a) Define drift velocity. [1 *mark*]

(b)(i) Derive an expression relating the current I, the number of free electrons per unit volume n, the drift velocity v of the free electrons and the cross-sectional area A of the wire. Hence, deduce an expression for the current density J. [5 *marks*]

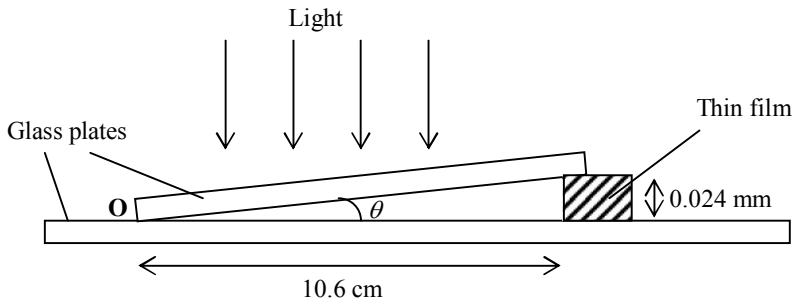
(ii) Show that the expression $J = \sigma E$, where σ is the electric conductivity and E is the electric field strength, is equivalent to Ohm's law. Hence, obtain a relationship between the resistance R of the wire with its cross-sectional area A. [4 *marks*]

(c) A 5.0 A current flows through a wire of length 1.50 m with square cross-sectional area of 1.2 mm^2 where the potential difference across the wire is 0.24 V.

(i) Calculate the drift velocity of the free electrons in the wire if the number of free electrons per unit volume is 1.5×10^{29} m^{-3}. [2 *marks*]

(ii) Find the electric conductivity of the wire. [3 *marks*]

12. An air wedge is formed between two glass plates touching at the end O and separated by a thin film of thickness 0.024 mm at a distance 10.6 cm from O as shown in the diagram below. The air wedge is illuminated with monochromatic light of wave length 500 nm and interference fringes are seen from the reflected rays.



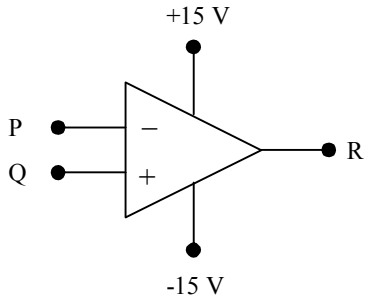
(a) Sketch the interference pattern formed and state whether a dark or bright fringe is formed at O. [3 *marks*]

(b) With the aid of a diagram, explain quantitatively on how the dark fringes and bright fringes of interference pattern are formed. [6 *marks*]

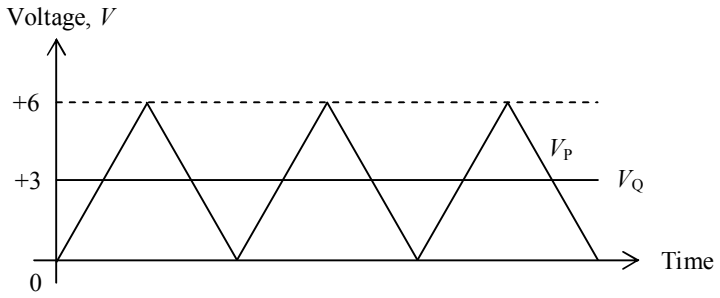
(c) Derive an expression for separation x between two consecutive dark fringes in terms of the wave length λ and the angle between the glass plates θ. [3 *marks*]

(d) Calculate the separation x between two consecutive dark fringes. [3 *marks*]

13. The diagram below shows the symbol of an operational amplifier.



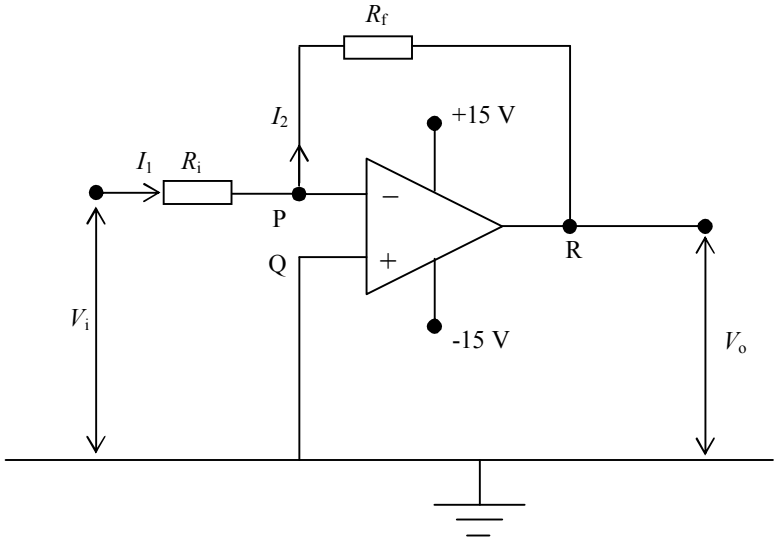
Voltage V_P and V_Q are applied simultaneously at P and Q as shown in the diagram below.



(a) Name the terminal P and terminal Q. [2 *marks*]

(b) Sketch the shape of output voltage V_R. [2 *marks*]

(c) The operational amplifier is then connected to a negative feedback circuit as shown in the diagram below.



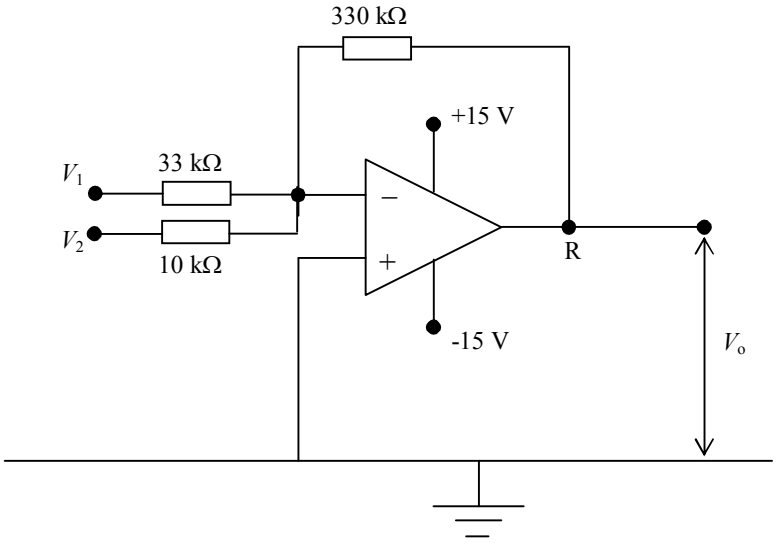
(i) State two advantages of negative feedback in an operational amplifier.

[2 *marks*]

(ii) Derive the closed loop gain in terms of R_i and R_f. State any assumptions your make.

[3 *marks*]

(d) Diagram below shows a circuit of operational amplifier.



(i) Name the circuit above. [1 *mark*]

(ii) Find the value of the output voltage V_o if $V_1 = 0.50$ V and $V_2 = 0.20$ V.

[3 *marks*]

(iii) What will happen to the output voltage V_o if $\pm 15V$ power supply is replaced by $\pm 9V$?

[2 *marks*]

14 (a) The bombardment of a beryllium nucleus by an a-particle produces a fundamental particle X, as follows:

$$\alpha + {}^{9}_{4}\mathrm{Be} \longrightarrow {}^{12}_{6}\mathrm{C} + \mathrm{X}$$

(i) Complete the equation above by giving the proton and nucleon numbers to the α -particle and X. [2 *marks*]

(ii) What are the α-particle and X? [2 *marks*]

(iii) State two important properties which cause X difficult to be detected. [2 *marks*]

(b) Determine the equivalent energy in MeV of a mass of 1 u. [5 *marks*]

(c) An element of unknown atomic mass is mixed with a ${}^{12}_{6}\mathrm{C}$ atom in a mass spectrometer. The radii of curvature of the element and ${}^{12}_{6}\mathrm{C}$ are 26.2 cm and 22.4 cm respectively.

What is possibly the element?

State any assumption you make. [4 *marks*]

Values of Constants (Nilai Pemalar)

Speed of light in free space	(Laju cahaya dalam ruang bebas)	$c = 3.00 \times 10^{8}$ ms^{-1}
Permeability of free space	(Ketelapan ruang bebas)	$\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}
Permittivity of free space	(Ketelusan ruang bebas)	$\varepsilon_0 = 8.85 \times 10\text{-}12$ Fm^{-1}
		$\approx (1/(36\pi)) \times 10^{-9}$ F m^{-1}
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Planck constant	(Pemalar Planck)	$h = 6.63 \times 10^{-34}$ J s
Unified atomic mass unit	(Unit jisim atom bersatu)	u = 1.66×10^{-27} kg
Rest mass of electron	(Jisim rehat electron)	$m_e = 9.11 \times 10^{-31}$ kg
Rest mass of proton	(Jisim rehat proton)	$m_p = 1.67 \times 10^{-27}$ kg
Molar gas constant	(Pemalar gas molar)	R = 8.31 J K^{-1} mol^{-1}
Avogadro constant	(Pemalar Avogadro)	L, $N_A = 6.02 \times 10^{23}$ mol^{-1}
Boltzmann constant	(Pemalar Boltzmann)	$k = 1.38 \times 10^{-23}$ J K^{-1}
Gravitational constant	(Pemalar gravity)	$G = 6.67 \times 10^{-11}$ Nm^{2}kg^{-2}
Acceleration of free fall	(Pecutan jatuh bebas)	$g =$ 9.81 m s^{-2}