KOLEJ MATRIKULASI NEGERI SEMBILAN

PROGRAM SCORE

SET 1

PROGRAM KECEMERLANGAN AKADEMIK (PKA)
KOLEJ MATRIKULASI NEGERI SEMBILAN
MINGGU KE 17

FIZIK (SP015)

2 jam

NO	MARKS
1	/2
2	/10
3	/13
4	/8
5	/5
6	/23
7	/8
8	/11
TOTAL	/80

LIST OF SELECTED CONSTANT VALUES

Speed of light in a vacuum	c	= 3.00 x 10^{8} m s^{-1}
Permeability constant	μ_0	= 4π x 10^{-7} H m^{-1}
Permittivity constant	ε_0	= 8.85 x 10^{-12} F m^{-1}
Elementary charge	*e*	= 1.60 x 10^{-19} C
Planck's constant	h	= 6.63 x 10^{-34} J s
Electron mass	m_e	= 9.11 x 10^{-31} kg
		= 5.49 x 10^{-4} u
Neutron mass	m_n	= 1.674 x 10^{-27} kg
		= 1.008665 u
Proton mass	m_p	= 1.672 x 10^{-27} kg
		= 1.007277 u
Deuteron mass	m_d	= 3.34 x 10^{-27} kg
		= 2.014102 u
Universal gas constant	R	= 8.31 J K^{-1} mol^{-1}
Rydberg's constant	R_H	= 1.097 x 10^{7} m^{-1}
Avogadro constant	N_A	= 6.02 x 10^{23} mol^{-1}
Boltzmann's constant	k	= 1.38 x 10^{-23} J K^{-1}
Gravitational constant	G	= 6.67 x 10^{-11} N m^2 kg^{-2}
Free-fall acceleration	g	= 9.81 m s^{-2}
Atomic mass constant	1 u	= 1.66 x 10^{-27} kg
		= 931.5 $\frac{MeV}{c^2}$
Electron Volt	1 ev	= 1.6 x 10^{-19} J
Constant of proportionality for Coulomb's law, $k = \frac{1}{4\pi\varepsilon_0}$		= 9.0 x 10^{9} m^2 C^{-2}
Atmospheric Pressure	1 atm	= 1.013 x 10^{5} Pa
Density of water	ρ_W	= 1000 kg m^{-3}

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$
4. $s = \frac{1}{2}(u + v)t$
5. $p = mv$
6. $J = F\Delta t$
7. $J = \Delta p = mv - mu$
8. $f = \mu N$
9. $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$
10. $K = \frac{1}{2}mv^2$
11. $U = mgh$
12. $U_s = \frac{1}{2}kx^2 = \frac{1}{2}Fx$
13. $W = \Delta K$
14. $P_{av} = \dfrac{\Delta W}{\Delta t}$
15. $P = \vec{F} \cdot \vec{v} = Fv\cos\theta$
16. $a_c = \frac{v^2}{r} = r\omega^2 = v\omega$
17. $F_c = \frac{mv^2}{r} = mr\omega^2 = mv\omega$
18. $s = r\theta$
19. $v = r\omega$
20. $a_t = r\alpha$
21. $\omega = \omega_o + \alpha t$
22. $\theta = \omega_o t + \dfrac{1}{2}\alpha t^2$
23. $\theta = \frac{1}{2}(\omega_o + \omega)t$
24. $\omega^2 = \omega_o^{\,2} + 2\alpha\theta$
25. $\tau = rF\sin\theta$
26. $I = \sum mr^2$
27. $I_{\text{solid sphere}} = \dfrac{2}{5}MR^2$
28. $I_{\text{solid cylinder/disc}} = \dfrac{1}{2}MR^2$
29. $I_{\text{ring}} = MR^2$
30. $I_{\text{rod}} = \dfrac{1}{12}ML^2$
31. $\sum\tau = I\alpha$

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

32. $L = I\omega$

33. $y = A\sin\omega t$

34. $v = \omega A\cos\omega t = \pm\omega\sqrt{A^2 - y^2}$

35. $a = -\omega^2 A\ \sin\omega t = -\omega^2 y$

36. $K = \frac{1}{2}m\omega^2(A^2 - y^2)$

37. $U = \frac{1}{2}m\omega^2 y^2$

38. $E = \frac{1}{2}m\omega^2 A^2$

39. $\omega = \frac{2\pi}{T} = 2\pi f$

40. $T = 2\pi\sqrt{\frac{l}{g}}$

41. $T = 2\pi\sqrt{\frac{m}{k}}$

42. $k = \frac{2\pi}{\lambda}$

43. $v = f\lambda$

44. $y(x,t) = A\sin(\omega t \pm kx)$

45. $v_y = A\omega\cos\ (\omega t \pm kx)$

46. $y = 2A\cos kx\sin\omega t$

47. $f_n = \frac{nv}{2L}$

48. $f_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$

49. $f_n = \frac{nv}{4L}$

50. $v = \sqrt{\frac{T}{\mu}}$

51. $\mu = \frac{m}{L}$

52. $f_a = \left(\frac{v \pm v_o}{v \mp v_s}\right) f$

53. $\sigma = \frac{F}{A}$

54. $\varepsilon = \frac{\Delta L}{L_o}$

55. $Y = \frac{\sigma}{\varepsilon}$

56. $U = \frac{1}{2}F\Delta L$

57. $\frac{U}{V} = \frac{1}{2}\sigma\varepsilon$

58. $\frac{Q}{t} = -kA\left(\frac{\Delta T}{L}\right)$

59. $\Delta L = \alpha L_o \Delta T$

60. $\Delta A = \beta A_o \Delta T$

61. $\Delta V = \gamma V_o \Delta T$

62. $\beta = 2\alpha$

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

63. $\gamma = 3\alpha$

64. $n = \frac{m}{M} = \frac{N}{N_A}$

65. $v_{rms} = \sqrt{\langle v^2 \rangle}$

66. $v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$

67. $PV = \frac{1}{3} N m {v_{rms}}^2$

68. $P = \frac{1}{3} \rho {v_{rms}}^2$

69. $K_{tr} = \frac{3}{2}\left(\frac{R}{N_A}\right)T = \frac{3}{2}kT$

70. $U = \frac{1}{2} fNkT = \frac{1}{2} fnRT$

71. $\Delta U = Q - W$

72. $W = nRT \ln \frac{V_f}{V_i} = nRT \ln \frac{P_i}{P_f}$

73. $W = \int P dV = P(V_f - V_i)$

74. $W = \int P dV = 0$

Answer **ALL** questions.

1 The Young's Modulus of a material is given by equation $Y = \frac{\sigma}{\varepsilon}$ where σ and ε are refer to the tensile stress and tensile strain respectively. What is the dimension of Young's Modulus?

[2 *marks*]

2 (a) The speed of a car travelling along a straight road decrease uniformly from 16 m s^{-1} to 12 ms^{-1} over 80 m. Calculate

(i) the deceleration of the car

(ii) the time taken for the speed to decrease from 16 ms^{-1} to 12 ms^{-1}

[3 *marks*]

(b) An object is thrown horizontally from the edge of a table with an initial velocity of 3 m s^{-1}. If the height of the table is 2.0 m, calculate

(i) the final velocity of object before it reach the floor.

(ii) the horizontal displacement of the object.

[7 *marks*]

3 (a) A fisherman on a stationary boat jumps off onto a jetty with a velocity of 1.5 m s^{-1} causing the boat to moves backwards.

(i) If the mass of the fisherman and boat are 65 kg and 450 kg, determine the velocity of the boat.

(ii) If the fisherman's feet are in contact with the jetty for 10 ms, determine the magnitude of the average force exerted on his feet.

[6 *marks*]

(b)

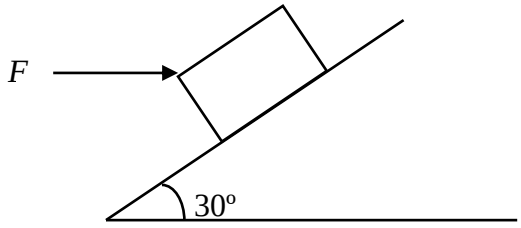

FIGURE 1

FIGURE 1 shows an object of mass 2.0 kg placed on a rough plane inclined at 30^0 with the horizontal. The coefficient of kinetic friction between the object and the plane surface is 0.25. A constant horizontal force, F = 50 N acts on the object and pushes it along the inclined plane with acceleration, a.

(i) Sketch a free body diagram showing all the forces acting on the object.

(ii) Calculate the acceleration of the object.

[7 *marks*]

4 (a)

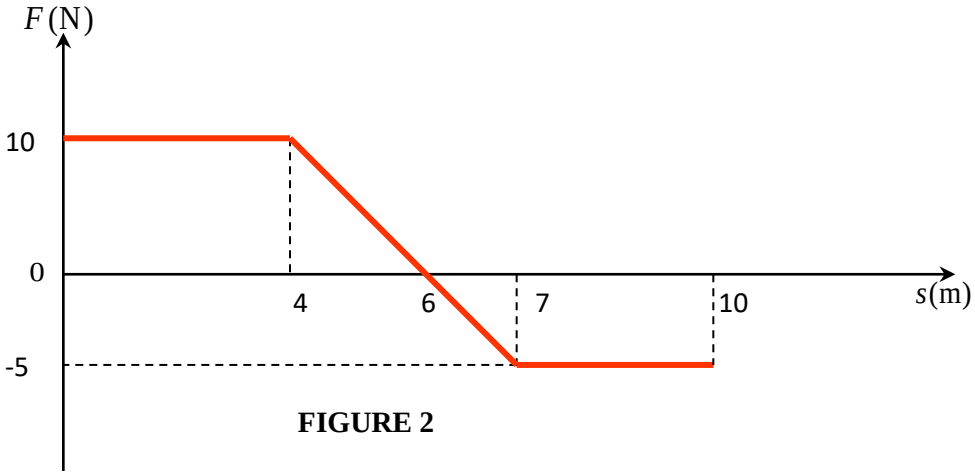

FIGURE 2

An object of mass 2.0 kg travels along horizontal floor under the action of force, F. **FIGURE 2** shows the graph of force, *F* against displacement, *s*. The speed of the object at $s = 0$ is 10 m s^{-1}. Determine the kinetic energy of an object at $s = 10$ m

[3 *marks*]

(b)

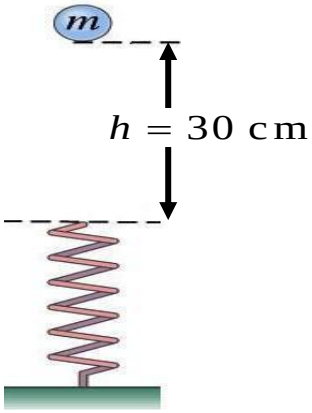

FIGURE 3

An object of mass 2.0 kg is placed 30 cm directly above the top end of a vertical spring as shown in **FIGURE 3**. It is then released from that height. The spring constant $k = 20$ N m^{-1}.

(i) Calculate the speed of the object just before it strikes the spring.

(ii) Determine the maximum compression, *x*.

[5 *marks*]

5 A 900 kg car moving at 10 m s^{-1} takes a turn around a circle with a radius of 25.0 m. Determine

(i) the angular velocity of the car.

(ii) the period of motion of the car.

(iii) the net force acting upon the car.

[5 *marks*]

6 (a) A mass is suspended vertically on the end of spring and undergoes simple harmonic motion of frequency 4 Hz and amplitude 2 cm. At displacement, x = 1 cm, determine the

(i) velocity of the mass.

(ii) acceleration of the mass.

[4 *marks*]

(b)

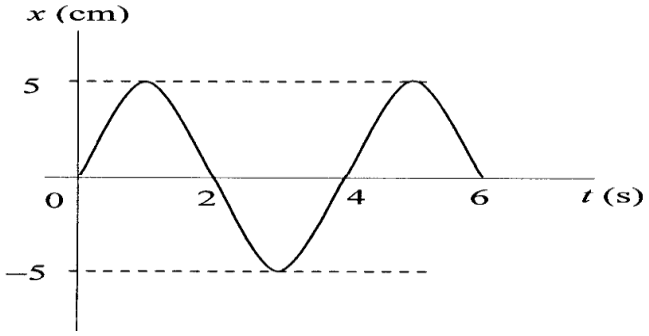

FIGURE 4

FIGURE 4 shows a displacement-time graph of a simple harmonic motion for an object with mass 25 g. Determine

(i) the angular frequency.

(ii) the equation for the simple harmonic motion.

(iii) the total energy.

[6 *marks*]

(c) The equation of progressive wave is given as

$$y = 6\sin 2\pi(2t - x)$$

where x and y are in meter and t in second. Determine the

(i) direction of the wave propagation.

(ii) wavelength, λ

(iii) frequency, f

(iv) wave speed.

(v) particle velocity at x = 2 m and t = 0.1 s.

[6 *marks*]

(d) Two waves in a long string are given by

$$y_1 = 8\sin(2\pi t - 2x) \qquad y_2 = 8\sin(2\pi t + 2x)$$

where y_1, y_2 and x in meter and t in second.

(i) Write an expression for the new wave when both waves are superimposed.

(ii) Determine the maximum amplitude, A for stationary wave.

[2 *marks*]

(e) A 50 cm closed pipe makes a humming sound when the wind blows across the opened end. If the speed of sound is 340 m s^{-1}, calculate

(i) second overtone of the pipe.

(ii) its fundamental frequency if the length of pipe is halved.

[2 *marks*]

(f) A fire engine is coming towards a station emitting siren at frequency 800 Hz. What is the possible frequency heard by a boy sitting in the station if the incoming fire engine is moving at 65 m s^{-1}? The speed of sound is 340 m s^{-1}.

[3 *marks*]

7 (a) An aluminium wire with diameter 1.5 mm is suspended from a rigid support with a load of 150 kg attached to its lower end. If the wire becomes 5.5 m long, what is the

(i) initial length of the wire.

(ii) extension of the wire.

(Young's modulus of aluminium is 7×10^{10} Nm^{-2})

[3 *marks*]

(b)

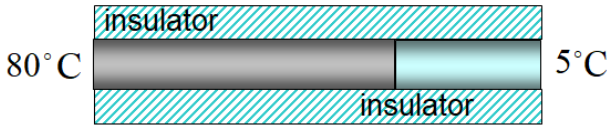

FIGURE 5

Two bars of the same diameter but different materials are joined end to end as shown in **FIGURE 5**. One end of the bars is kept at 80 °C while the other end is at 5 °C. Determine the steady state temperature at the interface of the bars if the length of the first bar is same as the second bar.

(Given thermal conductivity of the first bar is 240 W m^{-1} $^oC^{-1}$ and the second one is 110 W m^{-1} $^oC^{-1}$)

[3 *marks*]

(c) A block of gold has dimensions of 12 cm × 10 cm × 8 cm at temperature of 30 °C. If the temperature increases to 120 °C, determine the change in the volume of the gold block. The coefficient of linear expansion for gold = 1.4×10^{-6} $^oC^{-1}$.

[2 *marks*]

8 (a) A tank contains 1 m^3 of helium at a pressure of 1.3×10^5 Pa and temperature of 350 K. The temperature of the gas increases from 350 K to 370 K. What is the change in the internal energy of the gas?

[4 *marks*]

(b) The rms speed of hydrogen molecules at a particular temperature is 1330 m s^{-1}. What is the rms speed of nitrogen molecules at the same temperature?

Molar mass of hydrogen = 2 g mol^{-1} and molar mass of nitrogen = 28 g mol^{-1}.

[2 *marks*]

(c)

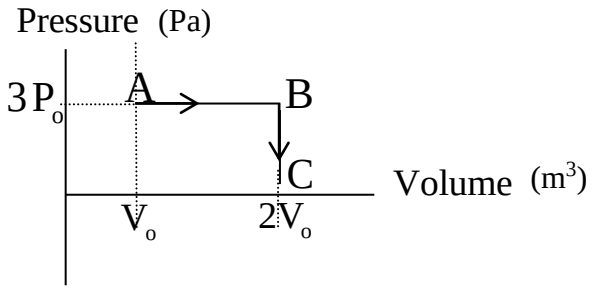

FIGURE 6

An ideal gas has undergoes two processes AB and BC as shown in **FIGURE 6**. 4000 J of heat is dissipated from the gas in the process BC. If P_o is 1.0 x 10^5 Pa and V_o is 0.02 m^3, calculate the

(i) work done for AB and BC.

(ii) changes in internal energy for BC.

[5 *marks*]