1997 UEBS paper Marking Schedule

MARKING SCHEDULE

The following formulae may be of use to you:

$\Delta p = Ft$	$d = r\theta$
$m_1x_1 = m_2x_2$	$v = r\omega$
$m_1x = m_2(d - x)$	$E_K = \frac{1}{2} I\omega^2$
$\theta = \omega_o t + \frac{1}{2}\alpha t^2$	$y = A\sin(\omega t + \phi)$
$\omega^2 = \omega_o{}^2 + 2\alpha\theta$	
$E = \frac{1}{2} LI^2$	$n\lambda = d\sin\theta$
$V = IX$	$n\lambda = \frac{dx}{L}$
$V = -L\frac{\Delta I}{\Delta t}$	$E_K = hf - \phi$
$R = \frac{\rho L}{A}$	$f' = f\frac{v_w}{v_w \pm v_s}$

Question 1: Linear Motion (11 marks)

(a) $p = mv$
$= 0.160 \times 25$
$= 4.0 \text{ kg m s}^{-1}$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(b) $\Delta p = m\Delta v$
$= 0.160\ (25 + 17)$
$= 6.72$
$= 6.7 \text{ kg m s}^{-1}$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(c) $\Delta p = Ft$
$6.72 = F \times 5.6 \times 10^{-5}$
$F = 120\,000 \text{ N}$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(d) $\Delta v = \pm(2 + 1)$
$= \pm 3 \text{ m s}^{-1}$
Answer *(1 mark)*

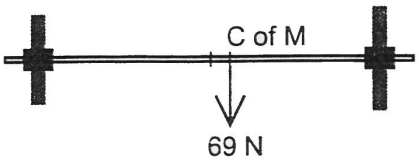
(e) $\Delta a = 4\% + 2\%$
$= 6\%$
Answer *(1 mark)*

(f) $\Delta a = 6\%$ of 512 349
$= 0.06 \times 512\,349$
$= 30741$
$a = 510\,000 \pm 30\,000 \text{ m s}^{-2}$
Percentage calculated *(1 mark)*
Uncertainty rounded to 1 significant figure *(1 mark)*
Acceleration rounded to the same decimal places as the 1 sf in the uncertainty *(1 mark)*

Question 2: Linear Motion (9 marks)

(a) $m_1x = m_2(d - x)$
$4.0 \times x = 3.0\ (2.0 - x)$
$7.0\,x = 6.0$
$x = 0.857$
$= 0.86 \text{ m}$
Formula and substitution *(1 mark)*
Proof shown *(1 mark)*

(b)



Correct value *(1 mark)*
Correct position and direction *(1 mark)*

(c) $F_L = 69 - 47$
$= 22 \text{ N}$
Answer *(1 mark)*

(d) $47 = F\cos 15°$
$F = 48.7$
$= 49 \text{ N}$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(e) $F_{unb} = ma$
$= 7.0 \times 8.8$
$= 61.6$
$F_{unb} = F_{up} - F_g$
$F_{up} = 61.6 + 70$
$= 131.6$
$= 130$ N
Correct unbalanced force *(1 mark)*
Answer *(1 mark)*

Question 3: Rotational Motion (9 marks)

(a) (i) $d = r\theta$
$0.55 = 0.015\,\theta$
$\theta = \frac{0.55}{0.015}$
Formula and substitution *(1 mark)*

(ii) $\theta = \omega_o t + \frac{1}{2}\alpha t^2$
$36.67 = 0 + 0.5 \times \alpha \times 0.88^2$
$\alpha = 94.71$
$= 95$ rad s^{-2}
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(b) (i) $\tau = Fd$
$= 192 \times 0.015$
$= 2.88$
$= 2.9$ Nm
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(ii) $\tau = I\alpha$
$2.88 = I \times 94.71$
$I = 0.03041$
$= 0.030$ kg m^2
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(c) To achieve the same angular acceleration, the same torque must be applied. If the radius is smaller the force must be larger and so Jane will find it harder.
Same torque *(1 mark)*
Greater force *(1 mark)*

Question 4: Rotational Motion (11 marks)

(a) From kinetic energy to gravitational potential energy.
Answer *(1 mark)*

(b) $E_K = \frac{1}{2}mv^2$
$2100 = 0.5 \times 75 \times v^2$
$v = 7.4833$
$= 7.5$ m s^{-1}
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(c) (i) $\Delta E_p = mg\Delta h$
$1400 = 75 \times 9.80 \times \Delta h$
$\Delta h = 1.905$
$= 1.9$ m
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(ii) $E_{K(ROT)} = E_{TOT} - E_P$
$= 2200 - 1400$
$= 800$ J
Answer *(1 mark)*

(d) $E_{K(ROT)} = \frac{1}{2}I\omega^2$
$800 = 0.5 \times I \times 18^2$
$I = 4.9383$
$= 4.9$ kg m^2
Formula and substitution *(1 mark)*
Answer *(1 mark)*

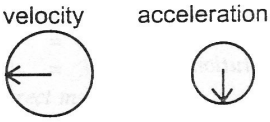
(e) John's rotational inertia will decrease because his mass is now more concentrated around his centre of mass.
Idea of mass concentration around centre of mass *(1 mark)*
Decreased rotational inertia *(1 mark)*

(f) Angular momentum is conserved so a decrease in rotational inertia will cause an increase in angular velocity.
Concept of conservation of angular momentum shown *(1 mark)*

Question 5: Simple Harmonic Motion (16 marks)

(a) Constant (angular) speed.
Answer *(1 mark)*

(b) velocity acceleration



(2 marks)

(c) Velocity is zero. *(1 mark)*
Acceleration is maximum. *(1 mark)*

(d) Downwards *(1 mark)*

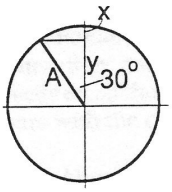
(e) $f = 89 \div 60$
$= 1.4833$
$= 1.5$ Hz
Revolutions per minute → revolutions per second *(1 mark)*
Answer *(1 mark)*

(f) $\omega = 2\pi f$
$= 2\pi \times 1.4833$
$= 9.32$
$= 9.3$ rad s^{-1}
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(g) $v = r\omega$
$= 0.20 \times 9.32$
$= 1.86$
$= 1.9\ m\,s^{-1}$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(h) $A = 0.20\ m$
Answer *(1 mark)*

(i)



$y = A \cos 30°$
$= 0.20 \times \cos 30°$
$= 0.1732$
$x = A - y$
$= 0.20 - 0.1732$
$= 0.027\ m$
Correct triangle or formula *(1 mark)*
Correct y *(1 mark)*
x = A - y *(1 mark)*

Question 6: DC Electricity (7 marks)

(a) (i) Decreases *(1 mark)*
(ii) Increases *(1 mark)*

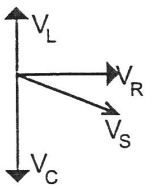
(b) (i) Decreases *(1 mark)*
(ii) Stays the same *(1 mark)*

(c) $P = IV$
$= 0.018 \times 1.5$
$= 0.027\ W$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(d) To ensure that there is as little heating as possible. *(1 mark)*

Question 7: AC Electricity (13 marks)

(a) and (b)



V_L and V_C correctly labelled *(1 mark)*
V_L and V_C correctly combined *(1 mark)*
Answer *(1 mark)*

(c) The current increases *(1 mark)*
because the impedance decreases. *(1 mark)*

(d) The change in current triggers an alarm *(1 mark)*

(e) $X_L = 24\ \Omega$
Same as capacitor voltage *(1 mark)*

(f) (i) $V = IR$
$= 0.300 \times 200$
$= 60\ V$
mA to A *(1 mark)*
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(ii) $V = IX$
$= 0.300 \times 24$
$= 7.2\ V$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(iii) $V_{SUPPLY} = 60\ V$
Same answer as (f) (i) *(1 mark)*

Question 8: Atomic Physics and Electromagnetism (14 marks)

(a) A to B *(1 mark)*

(b) The current in the circuit is maximised *(1 mark)*
because the positive potential of B ensures all photoelectrons contribute to the current. *(1 mark)*

(c) (i) The gradient is Planck's constant *(1 mark)*
which is a universal constant. *(1 mark)*

(ii) Different materials have different work function energies. *(1 mark)*

(d) $E = hf$
$= 6.626 \times 10^{-34} \times 3.82 \times 10^{14}$
$= 2.5311 \times 10^{-19}$
$= 2.53 \times 10^{-19}\ J$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(e) $E_K = hf - \Phi$
$= 2.5311 \times 10^{-19} - 2.41 \times 10^{-19}$
$= 0.12 \times 10^{-19}\ J$
Correct energy relationship *(1 mark)*

(f) R and S could not be used *(1 mark)*
because the frequency of the incident radiation is less than their cut-off frequencies. *(1 mark)*

(g) The magnetic field is strengthened. *(1 mark)*

(h) A break in the radiation beam causes a break in the current. *(1 mark)*
A break in the current reduces the magnetic attraction between plate and core allowing the plate to fall and complete the door opening circuit. *(1 mark)*

Question 9: Electromagnetism and Waves (18 marks)

(a) The voltage induced in the inductor opposes the supply voltage. *(1 mark)*

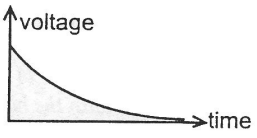
(b)
$V = IR$
$12 = I \times 4.5$
$I = 2.6667$
$= 2.7\ A$
Recognition that at maximum current the resistance in the circuit is 4.5 Ω. *(1 mark)*
Answer *(1 mark)*

(c)
$E = \frac{1}{2}LI^2$
$= 0.5 \times 2.0 \times 2.6667^2$
$= 7.1111$
$= 7.1\ J$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(d) *All answers were given full marks.* *(2 marks)*

(e) The voltage across PQ will oppose the voltage of the supply. *(1 mark)*
and so P will be the high potential end of the inductor. *(1 mark)*

(f)



Graph line decreases *(1 mark)*
Graph line has exponential shape *(1 mark)*
Graph line does not intersect the time axis (ie is asymptotic) *(1 mark)*

(g) Wave is longitudinal. *(1 mark)*

(h)

(1 mark)

(i)
$\lambda = 2L$
$= 0.370\ m$
Answer *(1 mark)*

(j)
$v = f\lambda$
$330 = f \times 0.370$
$f = 891.89$
$= 892\ Hz$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(k)

(1 mark)

Question 10: DC Electricity (10 marks)

(a) (i) Voltage of the source (9.0 V) *(1 mark)*

(ii)
$V = IR$
$9.0 = I \times 2200$
$I = 4.0909 \times 10^{-3}$
$= 4.1\ mA$
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(b) Voltage is equal to or close to zero *(1 mark)*

(c) (i) Decrease *(1 mark)*
(ii) Increase *(1 mark)*

(d) (i)
$R = (4700 - 2900) + \frac{1}{\left(\frac{1}{2200} + \frac{1}{2900}\right)}$
$= 1800 + 1251$
$= 3051$
$= 3100\ \Omega$
Correct parallel resistance *(1 mark)*
Added to correct series resistance *(1 mark)*

(ii)
$V = IR$
$9.0 = I \times 3050$
$I = 2.9499$
$V = IR$
$= 2.9499 \times 1251$
$= 3.690$
$= 3.7\ V$
Correct method *(1 mark)*
Answer *(1 mark)*

Question 11: The Doppler Effect (9 marks)

(a) The galaxies are moving towards earth. *(1 mark)*

(b) The star is moving away from earth. *(1 mark)*

(c)
$$f' = f \frac{v_w}{v_w + v_s}$$
$$5.089 \times 10^{14} = \frac{5.091 \times 10^{14} \times 2.9979 \times 10^8}{2.9979 \times 10^8 + v_s}$$
$v_s = 117819$
$= 1.2 \times 10^5\ m\,s^{-1}$
Correct interpretation of formula *(1 mark)*
Substitution *(1 mark)*
Answer *(1 mark)*

(d) $v = f\lambda$

$2.9979 \times 10^8 = 5.091 \times 10^{14}\ \lambda$

$\lambda = 5.888627 \times 10^{-7}$

$= 5.889 \times 10^{-7}$ m

Formula and substitution *(1 mark)*
Answer *(1 mark)*

(e) Colour of the double star would oscillate between the violet shifted colour and the red shifted colour because the light emitting star would oscillate between approaching and receding from earth.
*Correct description of what would be **seen**.* *(1 mark)*
Correct link between what is seen and the Doppler effect. *(1 mark)*

Question 12: Diffraction and Interference (14 marks)

(a) $\lambda = d \sin\theta$

$\sin\theta = 250 \times 10^3 \times 5.895 \times 10^{-7}$

$\theta = 8.4748$

$= 8.5°$

Lines/mm changed to lines/m. *(1 mark)*
Formula and substitution *(1 mark)*
Answer *(1 mark)*

(b) The diffraction angle will be smaller because the distance between the slits is increased. *(1 mark)* *(1 mark)*

(c) (i) A bright yellow fringe would be seen. *(1 mark)*

(ii) Equally spaced bright and dark fringes would be seen. *(2 marks)*

(d) $3\lambda = \frac{dx}{L}$

$1.000 \times 10^{-3} \times x = 3 \times 2.00 \times 5.895 \times 10^{-7}$

$x = 3.537 \times 10^{-3}$

distance $= 2 \times x$

distance $= 7.07 \times 10^{-3}$ m

Formula and substitution *(1 mark)*
Correct x *(1 mark)*
Correct distance *(1 mark)*

(e) Maximum angle is 90° *(1 mark)*

(f) Violet and blue will be seen because the angle of diffraction is proportional to the wavelength and these colours have shorter wavelengths than green. *(1 mark)* *(1 mark)*

Question 13: Atoms and Nuclei (11 marks)

(a) Fusion *(1 mark)*

(b) a = 16 *(1 mark)*
b = 8 *(1 mark)*

(c) Particle Y is a neutron *(1 mark)*

(d) $E = mc^2$

$3.5488 \times 10^{-13} = m \times (2.9979 \times 10^8)^2$

Formula *(1 mark)*
Substitution *(1 mark)*

(e) $(21.5912 + 6.6460) \times 10^{-27} = 1.6748 \times 10^{-27} + 3.9486 \times 10^{-30} + X$

$X = 26.55845 \times 10^{-27}$

$= 26.558 \times 10^{-27}$ kg

Correct idea of mass/energy conservation *(1 mark)*
Answer *(1 mark)*

(f) More stable than all other elements. *(1 mark)*

(g) Some of the mass of the constituent particles is stored as energy when the nucleons bind together.
Idea of mass/energy equivalence *(1 mark)*
Idea of the association of the energy with the binding process *(1 mark)*