QUALITATIVE: all principles, connected (4)
" " , not connected (3)
general idea (2)
some idea (1)

UNITS: 1 mark every time (SIG. FIG: 1→4 OK) 4 marks max per paper.

UNITS MUST BE IN FINAL ANSWER

RIGHT ANSWER : full marks. (UNLESS WORKING IS ASKED FOR)

FORMULA ONLY : 1 mark

TEE PHYSICS 1998
MARKING GUIDE

NOTE : These solutions have been produced as a marking guide to assist in the marking of scripts and are not intended to be model answers. Here the essential concepts are presented, which should appear in the answers in order to attain full marks.

SECTION A

A1. Period $T = 60 \div 13$ s (2 marks)

$= 4.61$ s (2 marks)

A2. Longitudinal wave - - - sound wave (1 mark)

Transverse wave - - - electromagnetic wave (1 mark)

KC Difference between traverse and longitudinal waves is the direction of *oscillation* of the "particles". WITH RESPECT TO DIRECTION OF ENERGY FLOW (2 marks)

A3 KC The particles in the medium are oscillating (2 marks)

- The lines represent the *amplitude* of the particles at that position in the tube. (2 marks)

MAX DISPLACEMENT ↑ MUST BE IN ANSWER

NODES/ANTINODES - 1 mark

3rd HARMONIC - 1 mark

A4. The fundamental note depends on the wavelength (1 mark)

The wavelength depends on the length. (1 mark)

Frequency is proportional to velocity (1 mark)

MOST WILL CALCULATE USING $c = f\lambda$

$$f_1 \div f_2 = c_1 \div c_2$$

$$f_2 = f_1 \times c_2 \div c_1 = 440 \times 985 \div 346 = 1253 \text{ cps}$$

(1 mark)

A5. KC Velocity in the horizontal direction is constant 2(1 mark)

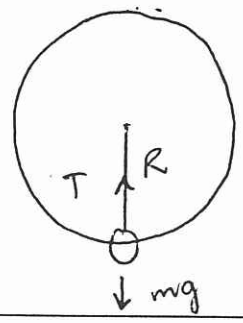
- Acceleration occurs in the vertical direction 2(1 mark)
- The net vector velocity is changing direction ~~(2 marks)~~

(Give 2 marks for suitable diagrams)

A6. KC Atoms have energy levels for electrons (1 mark)

- Atoms in such lights are ionized. (1 mark)
- Transitions of electrons between specific energy levels give photons of specific energy, and hence colour.
- DIFFERENT ELEMENTS HAVE DIFFERENT ENERGY LEVELS. ∴ DIFFERENT COLOURS EMITTED. (2 marks)

A7.



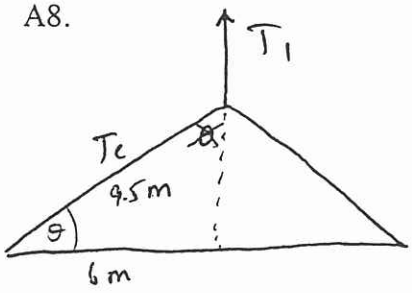
$T = mg + m\,v^2/R$ (2 marks)

$= 0.125 \times 9.8 + (0.125 \times 4.5^2)/R$ (1 mark)

$= 3.89$ N (1 mark)

ANSWER ONLY - 4 marks

A8.



$T_1 = m g = 2\,T_c \cos\theta$ ← SIN θ (1 mark)

$\sin\theta = 6/9.5$ ---> $\cos\theta = 0.775$ (1 mark)

$T_c = T_1 / 2\cos\theta$

$= 3500 \times 9.8 / (2\cos\theta)$ (1 mark)

$= \sout{13.3\text{ k N}}$ 2.23×10^4 N. (1 mark)

A9 Each floor is approximately 5 m so the total height is 50 m. (Range 25 to 75 m) (1 mark)

$v^2 = u^2 + 2\,a\,s$ MUST SHOW WORKING! (1 mark)

$v^2 = 2 \times 9.8 \times 50 = 31.1$ m s^{-1} (2 marks)

(Range 22.1 to 44.2 m s^{-1})

A10. photon energy $E = h\,c / \lambda$ (1 mark)

$E = (6.63 \times 10^{-34} \times 3 \times 10^8) / ((591 \times 10^{-9} \times 1.6 \times 10^{-19})$

$= 2.10$ eV (1 mark)

$E = E_3 - E_1$ NEGATIVE - 1 mark (1 mark)

$E_1 = -2.56 - 2.10 = -4.66$ eV -7.46×10^{-19} J (1 mark)

A11. Lamp ~~A~~ X will be brighter (1 mark)

KC
- Current through the wires causes a fall in potential , $V = I R$ (2 marks)
- The potential difference across B will be less. (1 mark)

Alternatively, an argument about greater resistance causing less current is quite acceptable.

A12. $Y = F L / A e$ -----> $e = F L / A Y$

LENGTH OF WIRE CAN BE ANYTHING (1 mark)

Assume ♥ the brick has a mass of 3 kg (range 1-10)
♠ the gymnasium has a height of 12 m (range 5-25) (1 mark)

$e = 3 \times 10 \times 12 \div (1.8 \times 10^{-6} \times 1.16 \times 10^{11})$

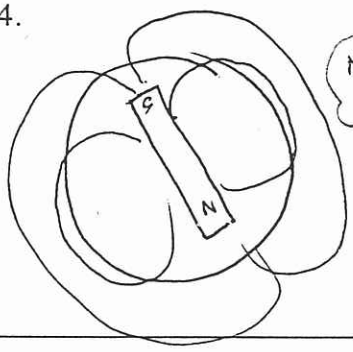
$= 1.7$ mm

$\frac{\Delta \ell}{\ell}$ CALCULATION OK (2 marks)

A13. KC
- ♦ high energy electrons (1 mark)
- ♥ deceleration in target (2 marks)
- ♠ energy emitted in the form of radiation (1 mark)

DEFINITIVE ENERGIES OF METAL - 2 marks only

A14. KC



MAGNET CAN BE VERTICAL

Earth's magnetic field lines do not follow the curvature of the Earth (1 mark)

Dip needle would be horizontal at the equator (1 mark)

MUST SHOW GOOD FIELD DRAWING

Diagram (2 marks)

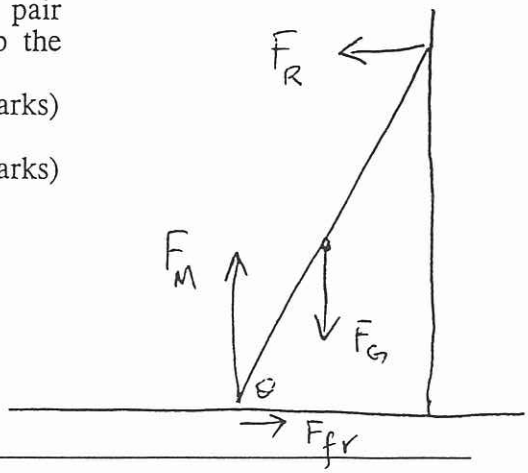
A15. KC As angle θ is ~~increased~~ DECREASED, the F_G - F_M pair exerts a greater torque and can not stop the ladder from slipping (2 marks)

AS θ DECREASES, F_R INCREASES

FRICTION FORCE - 1 mark

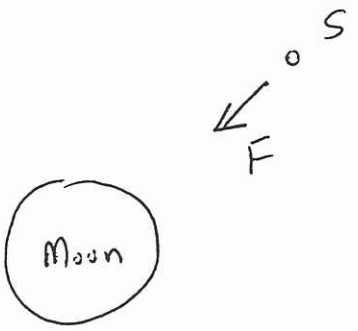
Diagram (2 marks)

"TORQUES" NOT ONLY ANSWER



SECTION B

B1. a)



(Diagram 2 marks)

b) $F = mg = GMm / D^2$

$g = GM / D^2$ (1 mark)

$D = R_m + h = 1.74 \times 10^6 + 2.5 \times 10^6$ (1 mark)

Substituting for the mass of the moon and G

$g = 0.273 \text{ m s}^{-2}$ (2 marks)

c) $T = 24 \text{ hours} = 24 \times 3600 \text{ sec}$ (1 mark)

$v = s / T = 2\pi R / T$ (1 mark)

$$F = \frac{GMm}{R^2} = \frac{mv^2}{R} = \frac{m 4\pi^2 R^2}{R T^2}$$

(1 mark)

$R^3 = GMT^2 / 4\pi^2$

Substituting for G, M and T, $R = 9.75 \times 10^6$ m (2 marks)

$h = R - R_m = 9.75 \times 10^6 - 1.74 \times 10^6$

$h = 8.01 \times 10^6$ m (1 mark)

ANSWER ONLY - FULL MARKS

B2. a) The horizontal component of velocity is

$v_H = v_0 \cos\theta$ (1 mark)

The time taken to travel to the goalposts is then

$t = s \div v_H = 36 \div (20 \cos 53)$ (1 mark)

$= 2.99$ s (1 mark)

b) After 2.99 s, the vertical displacement is

$s = ut + \frac{1}{2} g t^2$ (1 mark)

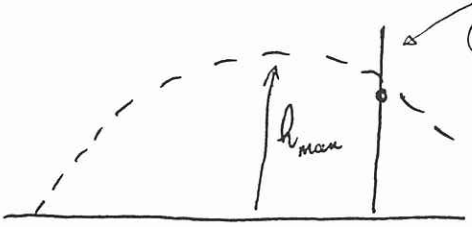
$= 20 \sin 53 \times 2.99 + \frac{1}{2} \times (-9.8) \times 2.99^2$

$= 3.94$ m 2(½ mark)

0.84 m

Thus the ball is ~~0.89~~ m above the bar. GOAL !!!! (1 mark)

c) (diagram 2 marks)



MUST SHOW BALL COMING DOWN

WILL HAVE TO CALCULATE THAT ITS HIGHEST BEFORE GOALS

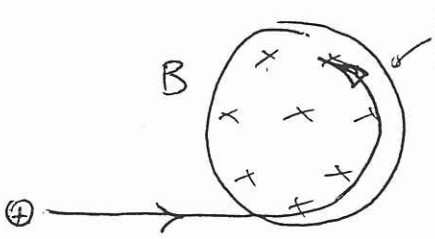
Time to reach the maximum height

$t = -u/a = 1.6$ s (2 marks)

Thus the ball reaches the maximum height before it gets to the goals. (1 mark)

RANGE 39.2 m ⇒ COMING DOWN

B. 3a)



CURVED PATH O.K.

Magnetic field direction (1 mark)
Path of ion (1 mark)
Correct relationship (1 mark)

CAN BE -VE ION ⇒ CHECK DIAGRAM

$F = qvB$

NEED TO USE FORMULA TO SHOW RELATIONSHIP

b) i) KC Each ion has the same charge, so the same force is exerted. (1 mark)

- Since the masses are different, path radii are different. (2 marks)

USE $F = ma$ - ACCELERATION IMPORTANT

ii) Radius of path would increase. (1 mark) ← 1 mark ONLY

$F = m v^2 / R$ ----->> $R = m v^2 / F$

$r = \frac{mv}{qB}$

KC The radius of the path is proportional to v^2. (2 marks)

c) $F = ma = qvB$ (1 mark)

$a = qvB / m = 1.6 \times 10^{-19} \times 4.52 \times 10^6 \times 0.115 / 9.63 \times 10^{-26}$ (2 marks)

$= 8.64 \times 10^{11}$ m s^{-2} (1 mark)

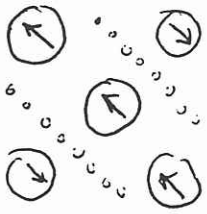
DON'T NEED DIRECTION

d) KC The ion only experiences a force when the velocity vector is at an angle to the magnetic field. (2 marks)

// ⇒ NO NETT FORCE OK.

WHEN v IS ⊥ TO B, MAXIMUM FORCE EXPERIENCED

B 4. a)



COULD BE ANGLED IF STUDENTS WORRY ABOUT EARTH'S FIELD - OK

(3 marks)
(2 marks if all directions reversed)

1 mark OFF - EACH INCORRECT ARROW

b) $B = \Phi / A$ (1 mark)

$B = \Phi / (\pi r^2) = 3 \times 10^{-5} / (\pi \times 0.02^2)$ (2 marks)

$= 23.9$ mT (1 mark)

CAN BE 7 TURNS - 1 mark

c) $emf = N \Delta \Phi / \Delta t$ (1 mark)

$= 8 \times (3 \times 10^{-5} - 0) / (55 \times 10^{-3})$ 2 (½ mark)

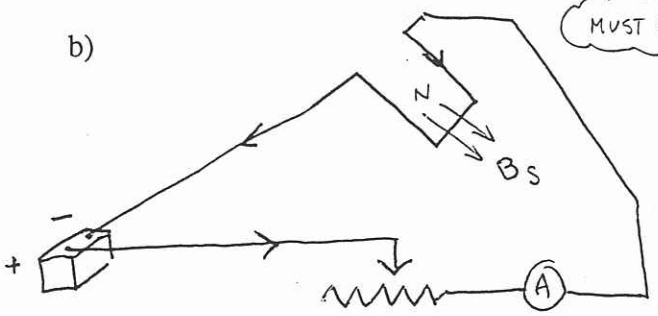
$= 4.36$ mV (1 mark)

B5 a) Magnetic field has to be horizontal (1 mark)

The force on the wire is perpendicular to the current **and** the magnetic field. (2 marks)

The force needs to be vertical. (1 mark)

b)



MUST SHOW THE MAGNET

battery 1 mark
~~rheostat 1 mark~~
ammeter 1 mark
connections 1 mark
direction of current 1 mark
position of weights 1 mark

c) Wire should always be in the same magnetic field 2 (½ mark)
~~This is done by having the wire at the same spot for every measurement~~ ~~(1 mark)~~
Add masses to the pan, $F = M g$ (1 mark)
Use moments to find the force on the wire. (1 mark)

CONVERSION

d) gradient $= (2.5 - 0.2) \times 10^{-3} / (4.2 - 0)$ 5.5×10^{-7} kgA^{-1} (1 mark)

$F = 0.6\,m\,g = I\,l\,B$ ----> $m = \{ l B / 0.6\,g \} I$

CONVERT mg → kg

(1 mark)

gradient $= l B / 0.6\,g$ (1 mark)

MUST ESTIMATE LENGTH

From the diagram, estimate l to be 60 mm (range 40 to 90 mm) (1 mark)

WIDTH OF MAGNET ≈ 3 "UNITS"

"UNITS" CAN BE mm, cm

$60 \times 10^{-3} \times B / (0.6 \times 9.8) = 2.3 \times 10^{-3} / 4.2$

$B = 2.3 \times 10^{-3} \times 0.6 \times 9.8 / (4.2 \times 60 \times 10^{-3})$ (1 mark)

$= 54$ mT (1 mark)

CHOICE – MARK FIRST QUESTION!

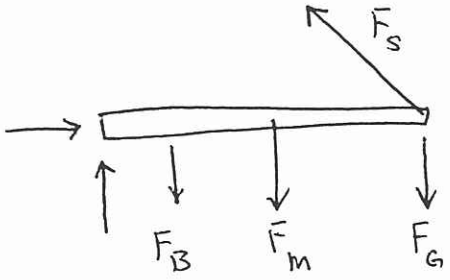
CHOOSE "BEST" ONE AND MARK

TELL CO-MARKER

USE POST-I

B 6A

a)



(1 mark off for each incorrect force)
(total 4 marks)

b) Take moments about P (1 mark)

$$m_B\, g \times 1.2 + m_P\, g \times 3 + m_G\, g \times 6 - F_W \sin 60 \times 6 = 0$$ (2 marks)

$$F_W = (45 \times 9.8 \times 1.2 + 20 \times 9.8 \times 3 + 15 \times 9.8 \times 6) / 6 \sin 60$$ (1 mark)

$$F_W = 385 \text{ N}$$ (1 mark)

c) When the bear is a distance x along the beam, the tension in the wire is 650 N (1 mark)

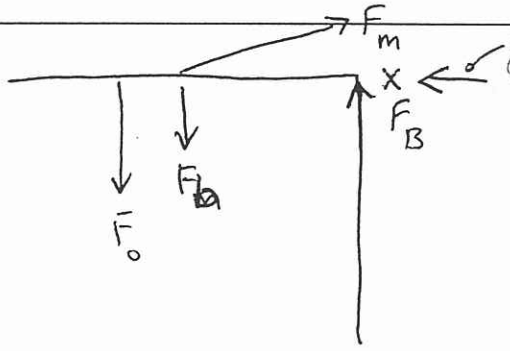
$$45 \times 9.8 \times x + 20 \times 9.8 \times 3 + 15 \times 9.8 \times 6 = 0$$ (2 marks)

$$x = \{ 650 \sin 60 \times 6 - 20 \times 9.8 \times 3 - 15 \times 9.8 \times 6 \} / (45 \times 9.8)$$ (1 mark)

$$x = 4.33 \text{ m}$$ (1 mark)

B6B

a)



MUST HAVE COMPONENT TO LEFT

(1 mark off for each incorrect force)
(total 4 marks)

CENTRE OF MASS OF UPPER BODY COULD BE ANYWHERE ⇒ MANY ANSWERS

b) Take moments about X (1 mark)

$$F_m \sin 12 \times 0.5 - m_b\, g \times 0.5 - m_0\, g \times {}^2/_3 = 0$$ ½ (½ mark)

$$F_m = \{ 35 \times 0.5 \times 9.8 + 20 \times {}^2/_3 \times 9.8 \} / (0.5 \sin 12)$$

$$F_m = 2907 \text{ N}$$ (2 marks)

c) For F_m = 3500 N (1 mark)

$$F_m \sin 12 \times 0.5 - m_b\, g \times 0.5 - m_0\, g \times {}^2/_3 = 0$$ (2 marks)

$$m_0 = \{ 3500 \sin 12 \times 0.5 - 35 \times 9.8 \times 0.5 \} / (9.8 \times {}^2/_3)$$ (1 mark)

$$= 29.4 \text{ kg}$$ (1 mark)

B7Aa)

$$IL = 10 \log \{ I_2 / I_1 \}$$

$$90 = 10 \log \{ I_2 / 10^{-12} \}$$

$$I_2 = 10^{-3} \text{ W m}^{-2}$$ (2 marks)

(1 mark)

b) Intensities are added (1 mark)

Thus total intensity $= 3 \times 10^{-3}$ W m^{-2} (1 mark)

ADD INTENSITIES

$$IL = 10 \log \{ 3 \times 10^{-3} / 10^{-12} \}$$ (1 mark)

$$= 94.8 \text{ dB}$$ (1 mark)

CHANGE = 10 log 3 OK

c) $\lambda = {}^{c}/_{f}$ (1 mark)

Dolphins : $\lambda = {}^{1530}/_{10^5} = 1.53 \times 10^{-2}$ m (2 marks)

Bats : $\lambda = 346 / 150 \times 10^3$ (1 mark)

$= 2.31$ mm $(2.31 \times 10^{-3}$ m) (1 mark)

d) KC Reflections occur in the room 2 (1 mark)

Hearers receive both the direct and reflected sounds (1 mark)

The two sounds add to produce a louder sound (1 mark)

EITHER

e) KC The vocal chords vibrate to produce sound (1 mark)

- The tension can be changed (1 mark)
- The change in tension causes a change in frequency (1 mark)

HELMHOLTZ RESONATOR – f DEPENDS ON VOLUME

B7Ba) See B7A a)
b) See B7A b)
c) See B7A c)

d) KC The two instruments have almost the same frequency (1 mark)

- The sound from the two instruments produces beats (1 mark)
- When there are no beats, the frequencies are the same. (1 mark)

e) KC Lower frequencies have longer wavelengths (1 mark)

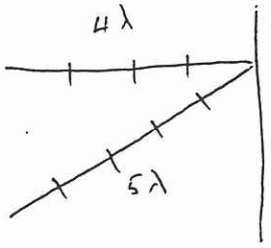
- The fundamental frequency depends on length (1 mark)
- To get lower frequencies, tubas have to be longer (1 mark)

C1 a) 700 nm to 400 nm (2 marks)

b) The semicircles represent wave fronts (2 marks)
(Alternatively, they connect points of equal phase)

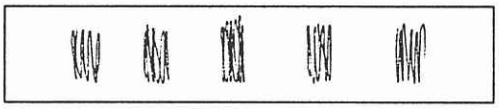
The distance between semicircles is one wavelength. (1 mark)

c) Diffraction (1 mark)

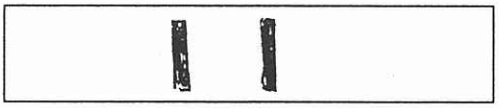
d) 

(2 marks)

KC When the two waves have travelled distances differing by an equal number of wavelengths, then they are in phase
(2 marks)

e) 

waves (KC Indicate fuzziness) (1 mark)



particles (KC Indicate sharpness) (1 mark)

KC Waves undergo diffraction, particles don't (2 marks)

f) Pattern would expand "DOUBLE" NOT REQUIRED (2 marks)

g) The bands would be closer together ADD BANDS BETWEEN EXISTING BANDS (1 mark)

Explanation FULL MARKS CLOSER OR MORE → 3 marks BOTH → 4 marks

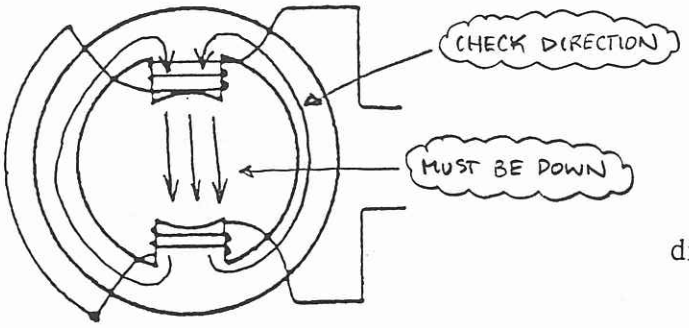
EXPLANATION NOT REQUIRED

KC Halving of wavelength means that the two waves need only half the path difference to obtain constructive interference.
(3 marks)

(Give credit for diagrams)

C2

a) i)

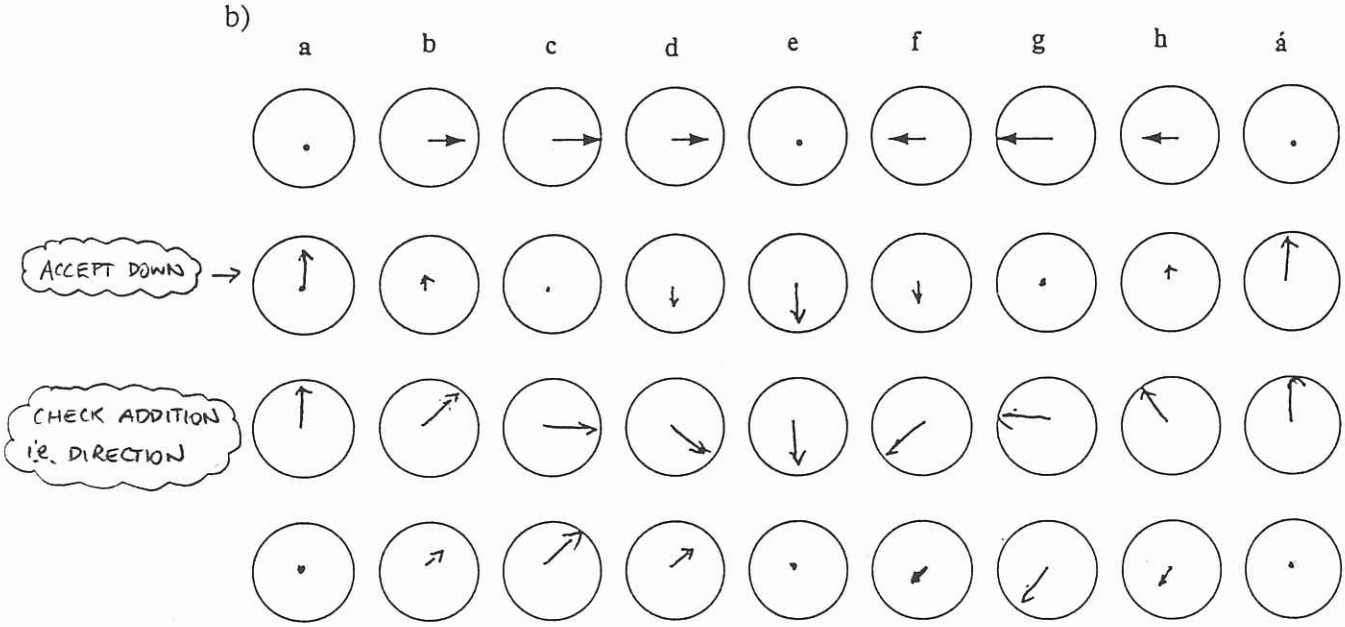


lines (2 marks)
direction (1 mark)

ii) KC Direction of magnetic field depends on the direction of the current. (2 marks)

- Direction of current reverses every half cycle. (1 mark)

b)



(2 marks each row)

c) i) KC Rotating field produces eddy currents in the rotor. (2 marks)

- Eddy currents will only flow if the rotor is a conductor (1 mark)

ii) KC Eddy currents produce a magnetic field (1 mark)

- Magnetic field produced opposes applied field (1 mark)
- The two magnetic fields repel (1 mark)

d) Rotation rate = 50 revolutions per second (1 mark)

In 8 seconds, there will be 50×8 = 400 revolutions (1 mark)