SIG FIG > 4 sensible 1 mark up to 5 marks
UNITS 1 mark off every time (answer only)

TEE PHYSICS 1999

MARKING GUIDE

NOTE : This marking guide has been produced for the use of those marking the physics paper, and its purpose is to provide an outline which can be used to give the greatest possible consistency in marking. The material following should NOT be regarded as a set of model answers. Further, it should be noted that this is a draft version, and in all likelihood will be modified following discussion at the markers' meeting.

SECTION A

1. Mechanical waves : Sound, water waves

   Electromagnetic waves : Radio, microwaves, X-rays.

   Deduct one mark for each incorrect answer.

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2. Magnet aligns north - south (2 marks)

   (Students who say that the magnet will oscillate before coming to rest can also be given full marks).

   2 marks maximum for answers that say magnet moves to side of bowl.

KEY CONCEPT → Magnets line up with the earth's magnetic field. (2 marks)

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3. A: Neutral
   B : Stable
   C : Unstable

   Two marks only if one incorrect answer.

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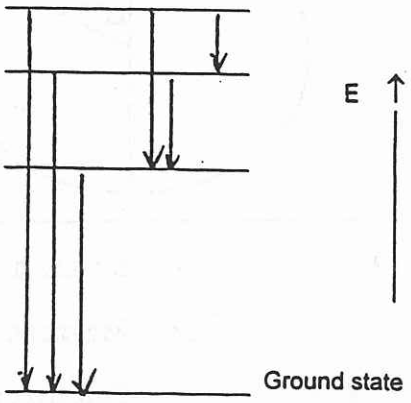
4. 6 lines (1 mark)

   Transitions as shown (3 marks)

Arrows wrong way - deduct 2 marks.



Must show some working!

5. Assume sprinter reaches maximum speed in 10 m (range 5-20 m → 40m) (1 mark)

Assume maximum speed 100/10 = 10 m s^{-1} (1 mark)

$2 a s = v^2 - u^2$ (1 mark)

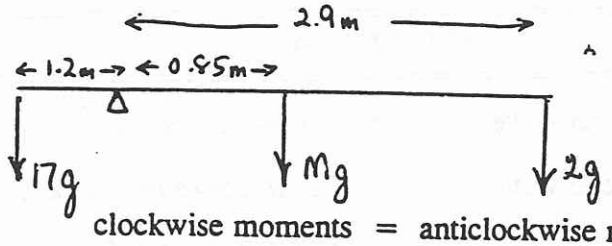
$a = (v^2 - u^2) / (2 s) = 100 / (2 \times 10)$

$= 5 \text{ m s}^{-2}$ 1 mark

Acceleration over complete 100 m is wrong. - give 2 marks only.

Be lenient on the time.

6.



(1 mark)

clockwise moments = anticlockwise moments

$M g \times 0.85 + 2 g \times 2.9 = 17 g \times 1.2$

$M = (17 \times 1.2 - 2 \times 2.9) / 0.85$ (2 marks)

$= 17.2$ kg (1 mark)

31 kg - 2 marks (Puts both masses on 1 side!)

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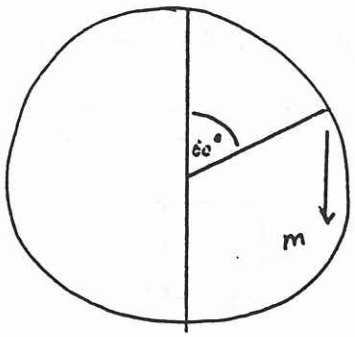
7. $\Delta l / l = 4.2 / 100$ (1 mark)

$Y = F l / A \Delta l = 100 \times 100 / (100 \times 10^{-6} \times 4.2)$ (2 marks)

$= 2.38 \times 10^7 \text{ N m}^{-2}$ (1 mark)

Δl error - give 2 marks.

8.



(diagram 1 mark) If diagram given

torque $\tau = r F$ (1 mark)

$r = 400 \times 10^{-3} \sin 60$ ← 1 mark for $\sin 60°$.

$F = 10 \times 10^{-3} \times g$ (1 mark)

$\tau = 400 \times 10^{-3} \sin 60 \times 10 \times 10^{-3} g$

$= 3.39 \times 10^{-2} \text{ N m}$ (1 mark)

9.

- Switch turns on current in coil (1 mark)
- Magnetic field is generated in the coil (1 mark)
- Soft iron core magnetizes, attracts iron armature (1 mark)
- Armature closes contacts C which turns on light. (1 mark)

with full marks.

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10. Light X is brighter than light Y (1 mark)

- There is a voltage drop in the long pair of wires due to their resistance. (2 marks)

Hence the potential across lamp Y is less. (1 mark)

could be considered together.

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11. The lights would be equally bright (almost) (1 mark)

- Much less current is used to deliver the same power to the lights (2 marks)

so the voltage drop is much less. (1 mark)

12.
- Each element has its own energy levels. * Electrons are excited to higher levels by absorbing energy ← 1 mark (1 mark)
- Light is emitted when electrons transfer between energy levels (1 mark)
- The colour of the light depends on the difference between energy levels (1 mark)

NOTE that credit should be given for energy level diagrams.

13.
- The fundamental note will have the same frequency. ← just mentioning this - 1 mark (1 mark)
- The number and intensity of higher harmonics determines the quality of the sound. (3 marks) ← 4 mark

unique mix of harmonics (full marks)

Just mentioning "quality" - 1 mark

mix of harmonics - 2 marks.

NOTE that students who point out that the attack and decay of harmonics are important can also be awarded three marks.

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14. Estimate radius of hammer as r = 2 m (range 1 - 3 m) (1 mark)

Estimate one turn per second (range 0.5 - 2) (1 mark)

Can estimate velocity (up to 30/40 ms^{-1}) 10 - 30 ms^{-1}

$$v = s/t = 2\pi r/t$$ (1 mark)

$$F = mv^2/r = (m/r) \times (4\pi^2 r^2 / T^2)$$

$$= 4\pi^2 m r / T^2$$

$$= 4\pi^2 \times 7 \times 2 \div 1^2 = 550 \text{ N}$$

(1 mark)

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15. Energy of one photon $E = hf = {}^{hc}/_{\lambda}$ (1 mark)

The number of photons per second is (Energy per second) ÷ (Energy per photon) (1 mark)

$N = 100 \times \lambda \div (h\,c)$

$= (100 \times 680 \times 10^{-9}) \div (6.63 \times 10^{-34} \times 3 \times 10^{8})$ (1 mark)

$= 3.42 \times 10^{20}$ photons per second (1 mark)

SECTION B

1. a) The centripetal force on the satellite is

$F = M v^2 / r = {}^{G M m}/_{r^2}$ (1 mark)

$v^2 = {}^{G M}/_{r} = \dfrac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(6.37 \times 10^{6} + 350 \times 10^{3})}$ (2 marks)

$v = 7.70 \times 10^{3}$ m s^{-1} (1 mark)

b) Since $F = m g = {}^{G M m}/_{r^2}$

$g = G M / r^2$ (1 mark)

$= \dfrac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(6.37 \times 10^{6} + 350 \times 10^{3})^2}$ (2 marks)

$= 8.83$ m s^{-2} (1 mark)

This is 10% less than at the earth's surface, so the statement is a reasonable approximation.

Method is most important.

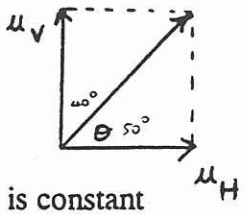
Can be done by ratio of $\frac{r_E}{r_{satellite}}$ i.e. $g \propto \frac{1}{r^2}$

1 mark off for wrong θ.

can use 50°/40° /etc.

2. a) Horizontal component $u_H = u_0 \cos\theta$ 50° (1 mark)

Vertical component $u_V = u_0 \sin\theta$ 50° (1 mark)



b) i) The horizontal component of the velocity is constant (1 mark)

Must explain your steps!

thus $s_H = u_H t$ (1 mark)

ii) The vertical displacement is given by

Look at the overall understanding

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

where u is the initial vertical velocity and a is g (1 mark)

iii) If D is the distance to the green,

$x = D - s_H$ (2 marks)

c) On landing, the vertical displacement is zero (1 mark)

so $0 = u_V t + \frac{1}{2} a t^2$

$t = 2u_V / a$

range $= \frac{v^2}{g} \sin 2\theta$

The horizontal distance travelled is 100 m

$s = u_H t = 2 u_V u_H / g = 2 u_0^2 \cos 50 \sin 50 / 9.8$

$u_0^2 = 100 \times 9.8 / (2 \cos 50 \sin 50)$ (1 mark)

$u_0 = 31.5 \text{ m s}^{-1}$ (1 mark)

The time in the air is

$t = -(2 \times 31.5 \times \sin 50) / (-9.8) = 4.92 \text{ s}$ (1 mark)

d) The time taken for the ball to travel 70 m is

$t = 70 / u_H = 70 / (u_0 \cos 50)$ (1 mark)

The height of the ball after travelling 70 m is

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

$= 31.5 \sin 50 \times 70 / (31.5 \cos 50) + \frac{1}{2} \times (-9.8) \times \{70 / (31.5 \cos 50)\}^2$

$= 24.8 \text{ m}$ (1 mark)

Thus the ball will clear the tree.

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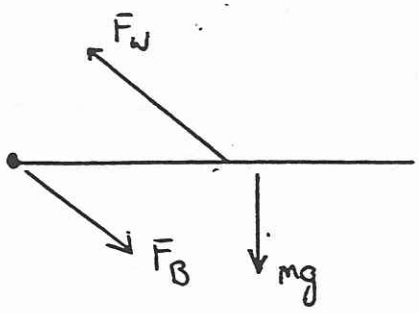
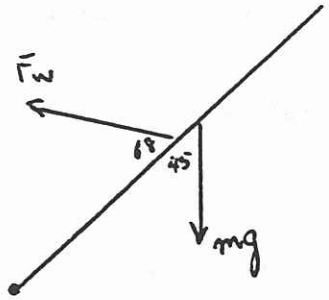
3. a)



(1 mark for diagram)
(1 mark for each force)

b)



(1 mark for diagram)

Taking moments about the joint J,

$(F_w \sin 68) \times 1.5 = m\,g \sin 45 \times 2$

$F_w = 2 \times 20 \times 9.8 \sin 45 \,/\, (1.5 \sin 68)$ (2 marks)

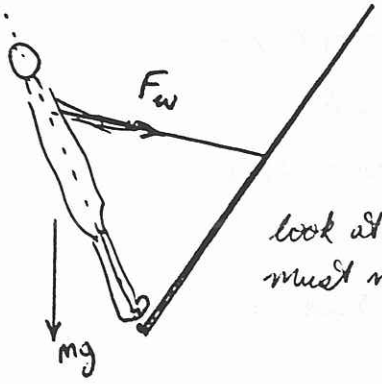
$= 199$ N (1 mark)

c) ➪ As the mast is raised, the component of the gravitational force on the mast perpendicular to the mast decreases.

(2 marks)

➪ Less torque is required to maintain equilibrium (2 marks)

d)



look at diagram. must match answer.

(2 marks)

➪ The windsurfer must lean back so the gravitational force on her can provide a counterclockwise torque.

(2 marks)

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must have I, field + compass all correct (full marks)

no explanation necessary.

4. a)

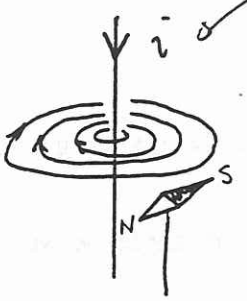

Diagram (1 mark)
Field is circular (1 mark)
Compass orientates along field (1 mark)
Compass is in correct direction (1 mark)

b) Force on spoon = $i l B = m g$ (1 mark)

Estimate :

Mass of teaspoon = 50 g (range 10 - 100)
length of spoon in field = 100 mm (range 20 - 200) (2 marks)

$F = IlB \Rightarrow i = m g / (l B) = 0.05 \times 9.8 / (0.1 \times 0.5) = 9.8$ A (1 mark)

Be generous.

c) Method of electricity generation (1 mark)
Important environmental consequence (1 mark)
Cause of environmental consequence (1 mark)

solar power - 1 mark
no consequence - none!

Aesthetics not appropriate

NOTE : Cause of environmental consequence must have physical principle.

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5. a) A force is exerted on electrons by a magnetic field (F = q v B) (1 mark)
A This force is perpendicular to the motion of the electrons (2 marks)
A This causes motion in a circle (1 mark)

Explain why ↑B gives ↓r
i.e. $r = \frac{mv}{qB}$
(2 marks.)

Equation not needed

b) gradient = $(22 - 0.5) \times 10^{-2} / 4400$ (1 mark)

(0,0) is OK!

line of best fit - 1 mark only.

$= 4.886 \times 10^{-5}$ T m (1 mark)

can be in cm!

c) Centripetal force = force exerted by the magnetic field

$m v^2 / r = q v B$
$r = \{ m v / q \} \{ 1 / B \}$ } (1 mark)

Thus gradient = $\{ m v / q \}$ (1 mark)

$v = 4.886 \times 10^{-5} \times 1.6 \times 10^{-19} / (9.11 \times 10^{-31})$ (1 mark)

$= 8.58 \times 10^{6}$ m s^{-1} (1 mark)

d) A The drawing of a straight line enables the best mean value of the results to be ascertained and any anomalous results identified. (2 marks)

outliers

2 reasons.

("Improves accuracy" gets only one mark.)

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6. a) ☞ The magnetic flux in the coil is continuously changing and this generates an emf (Faraday's Law).

(2 marks)

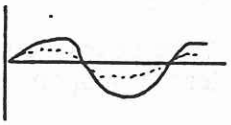
☞ The rate of change of flux depends on the angle between the coil and the magnetic field.

(1 mark)

This varies as sin θ or cos θ (depends on coil // to B)

(1 mark)

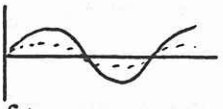
b) i) The voltage is doubled



(1 mark)

☞ The rate of change of flux is doubled. (1 mark)

ii) The voltage is doubled



(1 mark)

☞ The emf is proportional to the number of turns (1 mark)

iii) Voltage is doubled and frequency is doubled

(1 mark)

☞ Rate of change of flux is doubled and frequency is doubled (1 mark)

c) *Power for transport*

☞ Magnetic field can be generated by currents in coils (1 mark)

☞ Mass of the train is supported by magnetic repulsion rather than wheels

(1 mark)

Diagrams (2 marks)

Look for "good Physics" Practical implementation : Give two marks for any reasonable proposal with the correct physical principles. The use of permanent magnets is *not* practical.

(2 marks)

Domestic Power supply and consumption

☞ Information is stored by magnetizing the particles on the tape in one direction.

(2 marks)

Diagrams (2 marks)

☞ Information is read by passing the particles past a coil, which generates an emf in the coil.

(2 marks)

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7. a) Sound intensity level $IL_1 = \log_{10} \{I/I_0\}$

Thus $I_1 = I_0\, 10^{IL/10}$ (1 mark)

When only one speaker is operating, $I_2 = I_1 \div 3 = {}^1/_3\, I_0\, 10^{IL_1/10}$ (1 mark)

Thus $IL_2 = 10 \log \{I2/I0\} = 10 \log \{{}^1/_3\, 10^{8.85}\}$ (2 marks)

$= 10 \log {}^1/_3 + 88.5 = 83.7$ dB (1 mark)

b) ☞ The sound waves travel different distances, so that when they reach Bridgette, they are out of phase. (2 marks)

☞ For a lower sound level, there must be destructive interference. (1 mark)

(diagrams, 2 marks)

(Be reluctant to give full marks if no diagrams are provided.)

c) *Speaking and hearing*

i) ☞ There are loud spots and quiet spots. as you move around. (2 marks) 2

ii) ☞ There are two waves travelling in opposite directions. (2 marks)

☞ These waves have equal frequencies. (1 mark) 2

Must mention interference,

☞ Waves interfere to produce nodes and antinodes. (1 mark)

iii) Diagram showing nodes and antinodes (1 mark)

Method must include :

- identification of nodes and antinodes. (2 marks)
- wavelength is twice the distance between adjacent nodes or antinodes. (1 mark)

4

d ♫) *Musical instruments*

i) ☞ There are points of minimum and maximum vibrational amplitude. can see loop in string. (2 marks) 2

ii) ☞ There are two waves travelling in opposite directions (2 marks)

☞ These waves have equal frequencies. (1 mark)

☞ Waves interfere to produce nodes and antinodes. (1 mark) 4

iii) Diagram showing nodes and antinodes. (1 mark)

Method must include

- identification of nodes and antinodes. (2 marks)
- wavelength is twice the distance between adjacent nodes or antinodes. (1 mark) 4

SECTION C

common mistake - only 1 booster used!

1. a) Total mass = 1.825×10^6 kg (1 mark)

Most of this mass is fuel. ← Take note of fuel. (1 mark)

smaller mass ⇒ greater acceleration (3 marks)

b) ↱ Rockets have used all their fuel. (1 mark)

Empty - 1 mark
extra - mass - 2.
saving fuel - 3.

↱ If you took the rockets higher, you would be giving them extra PE (1 mark)

↱ Giving this extra PE uses fuel unnecessarily. (1 mark)

c) Acceleration is not uniform. (1 mark)

gravity decreasing - max 3.

Acceleration increases as the shuttle goes higher. (1 mark)

The loss of fuel means there is

Most important point. →
- less mass to accelerate (1 mark)
- the force remains constant. (1 mark)

engine thrust.

d) ↱ The surface of the earth is moving faster near the equator. (2 marks)

↱ The earth's motion is towards the east, and provides some of the KE needed by the shuttle in its orbit. (2 marks)

If all points covered in (d), give full marks for (e)

e) ↱ The earth's surface is moving towards the east. mention velocity - 2 marks. (1 mark)

Rocket falls in the ocean (safely) - no marks.

↱ Less fuel is required to orbit the shuttle in this direction. (2 marks)

must have this in answer.

f) A gravitational force is exerted on the astronaut. (1 mark)

↱ This force provides the centripetal force required to keep the astronaut in orbit. (3 marks)

"free fall" - 2 marks

Simulated gravity - no penalty.

Apparent weightless - OK (full marks)

2. a) ☞ The coil generates a high frequency magnetic field.

(1 mark)

☞ The oscillating magnetic field induces a current in the heating pan (Faraday's law).

(1 mark)

☞ Current heats cooking pan.

(1 mark)

Appropriate references to diagram : (2 marks)

b) ☞ Cooking pan needs to be a conductor *of electricity* (1 mark)

☞ so that current can flow in it. (1 mark)

c) ☞ Faraday's law says that emf depends on the rate of change of magnetic flux.

(2 marks)

☞ Higher frequencies result in greater rate of change of magnetic flux.

(2 marks)

d) ☞ The further the distance from the coil, the weaker the magnetic field.

(2 mark)

e) You are not likely to feel anything. *no rings / watches.* (1 mark)

☞ You are a poorer conductor than metals. (1 mark)

☞ The currents generated in your hand would be less than those which occur in metals

(Heating depends on I^2R) *must mention currents.* (2 marks)

Mark (e) + (f) with more rigour!

f) It would increase the rate of heating. (1 mark)

☞ There is a larger volume of metal in which eddy currents can circulate.

Less R, more I OK - full marks (2 marks)
