AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.2 WORK DONE AND ENERGY TRANSFER (PACK 1)

SCORE	PERCENTAGE
/282	%

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Q1.

(a) D

1

(b) C

1

(c) W = 300 × 45

1

W = 13 500

1

*allow 13 500 with no working shown for **2** marks*

(d) straight line drawn from 13 m / s to 0 m / s

1

finishing on x-axis at 65 s

1

[6]

Q2.

(a) (i) 100 (m)

1

(ii) stationary

1

(iii) accelerating

1

(iv) tangent drawn at *t* = 45 s

1

attempt to determine slope

1

speed in the range 3.2 – 4.2 (m / s)
dependent on 1st marking point

1

(b) (i) 500 000 (J)
ignore negative sign

1

(ii) 20 000 (N)
ignore negative sign
*allow **1** mark for correct substitution, ie*
500 000 = F × 25
***or** their part (b)(i) = F × 25*
provided no subsequent step

2

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(iii) *(kinetic) energy* transferred by heating

1

to the brakes

ignore references to sound energy

*if no other marks scored allow k.e. decreases for **1** mark*

1

[11]

Q3.

(a) 450

*allow **1** mark for correct substitution,*

ie 18 × 10 × 2.5 provided no subsequent step shown

2

(b) (i) friction between child ('s clothing) and slide

accept friction between two insulators

accept child rubs against the slide

accept when two insulators rub (together)

1

causes electron / charge transfer (between child and slide)

accept specific reference, eg electrons move onto / off the child / slide

reference to positive electrons / protons / positive charge / atoms transfer negates this mark

answers in terms of the slide being initially charged score zero

1

(ii) all the charges (on the hair) are the same (polarity)

accept (all) the charge/hair is negative / positive

accept it is positive/negative

1

charges / hairs are repelling

both parts should be marked together

1

(iii) charge would pass through the metal (to earth)

accept metal is a conductor

accept metal is not an insulator

accept there is no charge / electron transfer

accept the slide is earthed

accept metals contain free electrons

1

[7]

Q4.

(a) (i) friction

1

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(ii) air resistance

accept drag

friction is insufficient

1

(iii) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases
- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero
- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

(b) (i) 3360

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*allow **1** mark for correct substitution,*
ie 140 × 24 provided no subsequent step
*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J
*do **not** accept j*
*do **not** accept Nm*

1

(ii) decreases
accept an alternative word / description for decrease
do not accept slows down

1

temperature
accept thermal energy
accept heat

1

[13]

Q5.

(a) (i) gravitational potential (energy)

1

(ii) kinetic (energy)

1

(b) (i) slope or gradient

1

(ii) area (under graph)
*do **not** accept region*

1

(iii) starts at same y−intercept

1

steeper slope than original and cuts time axis before original
the entire line must be below the given line
allow curve

1

(c) (i) 31
and
31
*correct answers to 2 significant figures gains **3** marks even if no working shown*
*both values to more than 2 significant figures gains **2** marks:*
30.952…...
30.769….
65 / 2.1 and / or
*80 / 2.6 gains **1** mark*

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*if incorrect answers given but if both are to 2 significant figures allow **1** mark*

3

(ii) student 1 incorrect because 80 ≠ 65

1

student 2 correct because average velocities similar

*ecf from **(c)(i)***

1

student 3 incorrect because times are different

1

[12]

Q6.

(a) potential

1

(b) (i) 13 200

*allow **1** mark for correct substitution, ie 660 × 20 provided no subsequent step shown*

2

(ii) 16.5

allow 1 mark for correct

or

$\frac{\text{their (b)(i)}}{800}$ correctly calculated

substitution, ie $\frac{13\,200}{800}$ ***or*** $\frac{\text{their (b)(i)}}{800}$

provided no subsequent step shown

2

[5]

Q7.

(a) (i) distance vehicle travels during driver's reaction time

accept distance vehicle travels while driver reacts

1

(ii) any **two** from:

- tiredness
- (drinking) alcohol
- (taking) drugs
- speed
- age

accept as an alternative factor distractions, eg using a mobile phone

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2

(b) (i) 320 000

*allow **1** mark for correct substitution, ie* $\frac{1}{2} \times 1600 \times 20^2$
provided no subsequent step shown

2

(ii) 320000 **or** their (b)(i)

1

(iii) 40

or

$\frac{\text{their (b)(ii)}}{8000}$ correctly calculated

*allow **1** mark for statement work done = KE lost*

or

*allow **1** mark for correct substitution, ie*
*8000 × distance = 320 000 **or** their (b)(ii)*

2

(iv) any **one** from:

- icy / wet roads
  accept weather conditions
- (worn) tyres
- road surface
- mass (of car and passengers)
  accept number of passengers
- (efficiency / condition of the) brakes

1

(v) (work done by) friction
(between brakes and wheel)

*do **not** accept friction between road and tyres / wheels*

1

(causes) decrease in KE and increase in thermal energy

accept heat for thermal energy accept
KE transferred to thermal energy

1

(c) the battery needs recharging less often

accept car for battery

1

or
increases the range of the car

*accept less demand for other fuels **or** lower emissions **or** lower fuel costs*
environmentally friendly is insufficient

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as the efficiency of the car is increased

accept it is energy efficient

1

the decrease in (kinetic) energy / work done charges the battery (up)

accept because not all work done / (kinetic) energy is wasted

1

[14]

Q8.

(a) gravitational / gravity / weight

*do **not** accept gravitational potential*

1

(b) accelerating

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

(c) (i) any **one** from:

- speed / velocity
- (condition of) brakes / road surface / tyres
- weather (conditions)

accept specific examples, eg wet / icy roads
accept mass / weight of car friction is insufficient
reference to any factor affecting thinking distance negates this answer

1

(ii) 75 000

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*
***or** allow **1** mark for an answer 75*
***or** allow **2** marks for*
75 k(+ incorrect unit), eg 75 kN

2

joules / J

*do **not** accept j*
*an answer 75 kJ gains **3** marks*
for full marks the unit and numerical answer must be consistent

1

[8]

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Q9.

(a) 1800 (N)

*allow **1** mark for correct substitution ie 180 × 10 provided no further steps shown*

2

(b) 3780

or

their (a) × 2.1 correctly calculated

*allow **1** mark for correct substitution*

*ie 1800 **or** their (a) × 2.1 provided no further steps shown*

2

joule

accept J

accept any clear indication of correct answer

1

(c) 0

reason does not score if 0 not chosen

1

work is only done when a force makes an object move

accept distance moved is zero

accept no energy transfer (to the bar)

accept the bar is not moving/is stationary

'it' refers to the bar/weights

1

[7]

Q10.

(a) (i) 24

*allow **1** mark for converting time to 600 seconds*

***or** showing method ie 14400/10*

or $\frac{14400}{10 \times 60}$

provided no further steps shown

2

(ii) 24

ignore any unit

or

their (a)(i)

1

(b) (i) 20 45

***both** required – either order*

1

(ii) the block transfers energy to the surroundings

1

[5]

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Q11.

(a) 98

*allow **1** mark for correct substitution*
ie ½ × 0.16 × 35 × 35 provided no subsequent step shown
an answer of 98 000 scores 0

2

(b) (i) 9.6

*allow **1** mark for (change in velocity =) 60*
ignore negative sign

2

(ii) 9600

ignore negative sign
or
their (b)(i) ÷ 0.001 correctly calculated, unless (b) (i) equals 0

1

(c) increases the time

1

to reduce/change momentum (to zero)

only scores if 1st mark scored
decreases rate of change of momentum scores both marks provided there are no contradictions
accept decreased acceleration/deceleration
equations on their own are insufficient

1

[7]

Q12.

(a) (i) horizontal arrow pointing to the left

judge by eye
drawn anywhere on the diagram

1

(ii) 60 (N)

1

(at steady speed) resultant force must be zero

accept forces must balance/are equal
accept no acceleration
*do **not** accept constant speed*

1

(b) 1680

*allow **1** mark for correct substitution, ie 60 x 28 provided no subsequent step shown*

2

joule

accept J
do not accept j

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1

[6]

Q13.

(a) (i) 720

*allow **1** mark for correct substitution,*
ie 72 × 10 provided no subsequent step shown

2

(ii) 720
or
their (a)(i)

1

(b) (i) gravitational potential

allow gravitational
allow potential

1

(ii) 432

*allow **1** mark for correct substitution, ie* $\frac{21600}{50}$ *provided no subsequent step shown*

2

watt / W

1

[7]

Q14.

(a) (i) (connect) 30 (cells)

1

in series

1

(ii) current always flows in the same direction
or
current only flows one way

1

(iii) 36 000

*allow **1** mark for correctly converting 2 hours to 7200 seconds*
*answers 10 or 600 score **1** mark*

2

coulombs / C

*do **not** accept c*

1

(b) (i) 2160

*allow **1** mark for correct substitution, ie ½ × 120 × 6^2*
*answers of 1620 or 540 score **1** mark*

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2

(ii) reduce it

1

any **one** from:

- draws a larger current (from battery)
- motor draws greater power (from battery)
  accept energy per second for power
  accept more energy needed to move the bicycle
- greater resistance force (to motion) / air resistance / drag / friction
  accept less streamlined
  more mass to carry is insufficient

1

[10]

Q15.

(a) 572

*allow **1** mark for correct substitution,*
ie 220 × 2.6
*allow **1** mark for*
220 × 260 = 57 200
or
220 × 2600 = 572 000
but to score this mark the entire calculation must be shown

2

(b) (i) smooth curve drawn

accept a line that is extrapolated back to 0 degrees, but not through the origin
accept a straight line of best fit (point at 40 degrees can be treated as anomalous and line may stop at 30 degrees)
*do **not** accept straight lines drawn 'dot to dot' or directly from first to last point or a line going through the origin*

1

(ii) increases

accept a positive correlation
*do **not** accept proportional*

1

(iii) long plank

no mark for this, the marks are for the explanation

makes the angle small(er) (than a short plank)

accept increases the distance
accept small(er) slope

1

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a small(er) force is needed
or
short plank

no mark for this, the marks are for the explanation

a large(r) force is used over a short(er) distance (1)

less work done (1)

accept less energy transfer

1

[6]

Q16.

(a) (i) 75 000

*accept correct substitution for **1** mark*
ie 7500 × 10

2

newtons / N

*do **not** accept n*
*full credit for using g = 9.8 **or** 9.81*

1

(ii) 60 000 000

accept for both marks
their (a)(i) × 800 correctly calculated
*accept correct substitution for **1** mark*
ie their (a)(i) × 800

2

(b) (i) arrow drawn parallel (to) **and** down (the) slope

accept arrow drawn anywhere on the diagram

1

(ii) increases

1

GPE transformed to KE
or
speed increasing

accept is accelerating
however 'speed increasing' only scores if correctly linked to increasing kinetic energy

1

(c) so more likely to wear one
or
they know wearing a helmet is likely to / will reduce (risk) head injury
or
so can make an (informed) choice (about wearing one)

1

[9]

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Q17.

(a) (i) 50 (N)

ignore any units

1

(ii) resultant force

1

(iii) 4000

*accept their (a)(i) × 80 correctly calculated for **2** marks*
*allow **1** mark for correct substitution i.e. 50 × 80 or their (a)(i) × 80*
ignore any units

2

(b) (i) joule

1

(ii) heat

1

[6]

Q18.

(a) 47250

*answers of 1350/ 33750/ 48600 gain **1** mark*
*allow **1** mark for correct substitution using both 18 and 3*

2

(b) (i) 47250 or their (a)

accept statement 'same as the KE (lost)'
ignore any units

1

(ii) transformed into heat/ thermal energy

sound on its own is insufficient
accept transferred/ lost/ for transformed
*do **not** accept any other form of energy included as a list*

1

[4]

Q19.

(a) (i) a single force that has the same effect as all the forces combined

accept all the forces added / the sum of the forces / overall force

1

(ii) constant speed (in a straight line)

*do **not** accept stationary*

or constant velocity

1

(b) 3

*allow **1** mark for correct substitution into transformed equation*

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*accept answer 0.003 gains **1** mark*
*answer = 0.75 gains **1** mark*

2

m/s^2

1

(c) as speed increases air resistance increases

accept drag / friction for air resistance

1

reducing the resultant force

1

[7]

Q20.

(a) concentration / tiredness / drugs / alcohol

accept any reasonable factor that could affect a driver's reactions

*do **not** accept speed or any physical condition unrelated to the driver*

1

(b) 31.25

*credit for **1** mark correct attempt to calculate the area under the slope **or** for using the equation*
distance = <u>average</u> velocity (speed) × time

*credit for **1** mark use of correct velocity change (12.5) <u>and</u> correct time (5) **or** answer of 62.5*

3

(c) 2.5

*credit for **1** mark triangle drawn on slope **or** correct equation **or** two correct pairs of coordinates*

credit for 1 mark use of correct velocity change (12.5) and correct time (5)
accept time = between 4.8 and 5.2 if used in (b)

do not accept an attempt using one pair of coordinates taken from the slope

3

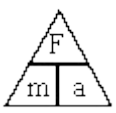
metres / second / second **or** metres / second / squared **or** m/s^2 **or** ms^{-2}

1

(d) (i) force = mass × acceleration

accept correct transformation

accept F = m × a

accept 

provided subsequent use of Δ is correct

*do **not** accept an equation in units*

1

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(ii) 2250

credit their (c) × 900 for 2 marks
*credit **1** mark for correct substitution*

2

[11]

Q21.

(a) (i) kinetic energy = $\frac{1}{2}$ × mass × speed^2

accept ke = $\frac{1}{2}$ mv^2

*do **not** accept KE = $\frac{1}{2}$ ms^2*

1

(ii) 13

allow 1 mark for correct substitution or transformation

2

(b)

*if B is at the top of the curve - **no** marks*

PE at A maximum
PE at B minimum
PE at C just less than **or** = to A

*do **not** accept wavy lines **or** very non-symmetrical*
accept straight lines or curves

1

difference between A and B is 5000 to 5200

1

[5]

Q22.

(a) (i) work (done) = force (applied) × distance (moved)

accept W = F × s or W = F × d

accept 

provided subsequent method is correct

1

(ii) 240 000

*allow **1** mark for correct substitution **or** correct use of 1200 (N)*

2

joules

accept J
*do **not** accept j / Nm*

1

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(b) 800 (watts)

accept 0.8 kW
*accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks*
*allow **1** mark for correct substitution*
*(a)(ii) ÷ 5 correctly evaluated for **1** mark*

2

(c) (i) any **one** from:

- needs to raise the chair / lift
- lifting more than one chair
  allow lifting more than 2 people
  implication of a heavier weight
- energy transfer to the surroundings
  correctly qualified
  accept loss for transfer
  *do **not** accept motor inefficient*
  *do **not** accept motor gets hot*
  *do **not** accept friction unless the location is specified as external to the motor*

1

(ii) electrical

accept electric

potential

***both** answers required for the mark*

1

[8]

Q23.

(a) (i) gpe = weight × height

accept Ep = mgh
accept pe= mgh

1

(ii) 1200

accept values using 9.8 (1)
*allow **1** mark for correct substitution*

2

(b) (i) 120

accept $\frac{\text{their (a)(ii)} \times 6}{60}$

1

(ii) 300

allow b(i) ÷ 0.4 for both marks
*allow **1** mark for correct transformation*

2

[6]

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Q24.

(i) kinetic energy = $\frac{1}{2} \times \text{mass} \times \text{speed}^2$

accept velocity for speed

accept KE = $\frac{1}{2} mv^2$

1

(ii) 32 000

accept 32 kJ

1

[2]

Q25.

(a) (i) gravitational potential

accept gravitational

accept potential

1

(ii) 2250 (N)

1

forces must be balanced

or

forces are equal and opposite

*do **not** accept because it is not moving*
*do **not** accept 'equilibrium' by itself*
*do **not** accept 'it is not balanced'*
*do **not** accept 'forces are equal'*
*do **not** accept 'forces are the same'*

1

(b) 1500

***1** mark for correct substitution*

2

[5]

Q26.

(a) (i) linear scales used

do not credit if less than half paper used

1

points plotted correctly

all of paper used

1

(straight) line of best fit drawn

allow a tolerance of ± half square

1

(ii) correct **and** straight line through origin

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***all** needed*
e.c.f. if their (a)(i) is straight but not through the origin - incorrect because line does not go through origin
credit a calculation that shows proportionality

1

(iii) 62 ± 0.5 (m)

*credit **1** mark for KE = 490000 **or** 490kJ*
*credit **1** mark for correct use of graph clearly shown*

2

(iv) any **one** from: wet **or** icy **or** worn **or** smooth road

accept slippery slope

brakes worn

accept faulty brakes

car heavily loaded
worn tyres
downhill slope

do not accept anything to do with thinking distance e.g. driver tired or drunk

1

(b) (i) acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

accept correct transformation

accept $\frac{v-u}{t}=a$

accept m/s² = $\frac{m/s}{s}$

*do **not** accept acceleration* = $\frac{velocity}{time}$

1

(ii) 56

accept –56

1

(iii) deceleration is reduced

accept deceleration is slower
accept acceleration

1

force on car and or passengers is reduced

accept an answer in terms of change in momentum for full credit

1

[11]

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Q27.

(a) potential; bucket/pulley

for 1 mark each

2

(b) 300

gains 2 marks

else working

gains 1 mark

2

[4]

Q28.

(a) (i) B unless unqualified

for 1 mark

1

(ii) B unless unqualified

for 1 mark

1

(iii) energy lost, doing work against air resistance/friction

for 1 mark

1

(b) intensity of gravity less (not zero)

for 1 mark

energies/restoring forces less

for 1 mark

2

[5]

Q29.

(a) 3

gains 1 mark

m/s^2

gains 1 mark

else working *gains 1 mark*

2

(b) 2850 ecf

gains 1 mark

N

gains 1 mark

else working

gains 1 mark

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2

(c) friction/air resistance increases with speed;
till frictional = max forward force;
then force/acceleration is zero

for 1 mark each

alternative limitation for safety

gains 1 mark only

3

[7]

Q30.

(a) 100

gains 2 marks

else working

gains 1 mark

2

(b) 100 ecf

for 1 mark

1

(c) rounds to 14 (accept 14.142 or 14.14) ecf

gains 3 marks

else working to $v^2 = 200$

gains 2 marks

else initial working v = 200

gains 1 mark

3

[6]

Q31.

(a) 20 m/s

gets 2 marks

Else working

gets 1 mark

2

(b) 10 m/s

1

(c) 20 m

gets 2 marks

Else working

gets 1 mark

2

(d) 12 000 N

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gets 2 marks

Else working

gets 1 mark

2

(e) 2 400 000 J

gets 2 marks

Else working

gets 1 mark

2

(f) (i) Ans to (e)

1

(ii) Ans to (e)/60
Else working

2

(iii) Ans to (ii)/5

1

[13]

Q32.

(a) $k = 1/2mv^2$
$k = 1/2.1.2.109.202$
$k = 2.4.1011$

for one mark each

3

(b) (i) 0.6.109

(ii) mass halved
speed halved
(speed)2 quartered
ke and/or power cut to one eight

for 1 mark each

5

[8]

Q33.

(a) there is a (maximum) forward force
drag/friction/resistance (**opposes** motion) (**not** pressure)
increases with speed
till forward and backward forces equal
so no net force/acceleration

any 4 for 1 mark each

4

(b) (i) $F = ma$
$10\ 000 = 1250a$
$a = 8$
m/s^2

for 1 mark each

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4

(ii) $ke = 1/2\ mv^2$
$ke = 1/2\ 1250.48^2$
$ke = 1\ 440\ 000$
J

for 1 mark each

4

(iii) $W = Fd$
$W = 10\ 000.144$
$W = 1\ 440\ 000$
J

for 1 mark each

4

[16]

Q34.

(a) AB

for 1 mark

1

(b) (i) 0.7

for 1 mark each

1

(ii) 16.8

gains 2 marks

2

but correct working
(d = v.t, d = 24 × 0.7, or in terms of area under graph)

gains 1 mark

1

(c) $a = (v-u)/t$
$= 24/4$
$= 6$
m/s^2

(see marking of calculations)

(can work in terms of graph gradient)

4

(d) $d = v.t$
$= 24/2 \times 4$
$= 48$

(see marking of calculations)

(can work in terms of area under graph)

3

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(e) F = ma
= 800 × 6
= 4800

(see marking of calculations)

3

[15]

Q35.

(a) p = mgh
= 50 × 10 × 4 = 2000
J/Nm
(see marking of calculations)

4

(b) $k = ½ mv^2$
$= ½ \times 50 \times 8^2$
= 1600
J/Nm
(see marking of calculations)

4

(c) work is done against air resistance
fall of her C of G differs from rise in climbing stairs
part of gained pe used to rotate body
diver gains PE on take-off

any 2 for 1 mark each

2

[10]

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